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CONTENTS.

EDITORIAL:
Needed Improvements . . . 271
Electric Service During Storms . . . 271
The Tantalum Lamp . . . 272
The Electrical Operation of Textile Factories . . . 273
A Possible Danger to High-Tension Apparatus . . . 273
Single-Phase Motors on Polyphase Systems, by H. W. Doubrava . . . 274
Street Railway Conditions in Massachusetts . . . 277
BOOK REVIEWS . . . 278
The Tantalum Lamp, by Dr. W. Von Bolton and Dr. O. Feuerlein . . . 279
Application of Electricity to Steam Roads . . . 283
Electric Hoisting at a French Colliery . . . 284
The New Paris Electric Railroad, by C. L. Durand . . . 285
Car Equipment of a Single-Phase Railway System . . . 290
The Indianapolis & Cincinnati Traction Company . . . 291
Dinner of the Electrical Contractors' Association . . . 296
Incandescent Lamp Manufacturers' Meeting . . . 297
Meeting of Telephone Men . . . 297
American Electrochemical Society . . . 297
Report of the New York State Railroad Commissioners on Traffic Conditions in Greater New York . . . 297
Regular Meeting of the American Institute of Electrical Engineers . . . 297
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 298
Group Photograph Annual Dinner American Institute of Electrical Engineers . . . 300
Street Railway History and Organization . . . 301
INDUSTRIAL SECTION:
Walrath Gas and Gasoline Engines . . . 302
Westinghouse Sales Meeting . . . 303
Electro-Lifting Magnets . . . 304
Motor-Starting Panel with Circuit-Breakers . . . 305
New District Offices of the National Electric Company . . . 305
The Peerless Thawing Transformer . . . 306
The Cost of Lighting . . . 306
Central Electric Company's Plant Burned . . . 306
CURRENT ELECTRICAL NEWS . . . 307

NEEDED IMPROVEMENTS.

A plan is now before the Board of Rapid Transit Railroad Commissioners of the city of New York which provides a remedy for the intolerable condition now existing at the New York terminus of the Brooklyn bridge. It is proposed to build two four-track elevated structures connecting the Brooklyn bridge with the Williamsburg bridge. These, with the two bridges, will form a loop over which the bridge trains will circulate in both directions. When the intermediate bridge is built, it will be included in the system. This plan is the best that has yet been offered. It does away with the bridge terminals and thus makes better service possible. At the same time, it provides for the future. The plan can not be carried into execution too soon.

While on the subject of rapid transit improvement, there is another system which has attracted considerable attention. There seems to be no doubt of the inability of the Brooklyn Rapid Transit Company to deal satisfactorily with the situation as it exists to-day in Brooklyn. The service is uncertain and irregular. Delays of from twenty minutes to an hour are the rule rather than the exception. This condition is getting worse from day to day. It is impossible for an outsider to say just what is the trouble. Possibly more cars are needed, or more power at the stations. Probably it is a lack of both. The situation has now been taken in hand by the New York State Railroad Commission, and an elaborate plan of relief outlined.

ELECTRIC SERVICE DURING STORMS.

This winter, so far as it has gone, has brought its full share of severe storms. Some of these have been accompanied by high winds. The fall of snow and sleet has been exceptionally great, and, altogether, the winter promises to establish a new record for bad weather.

The effect of these storms on the electric services has been felt in all directions, but it is the country districts that suffer most. Although our overhead lines are being erected more and more substantially, they have not yet reached a point where we can bid defiance to a high wind, accompanied by sleet.

In the cities, conditions are better, for, as a general rule, the wires are underground, and are independent of the weather. Thus, during the recent severe storm there was no interruption whatever of the lighting in the city of New York.

About the same remarks apply to the railways, for on the country lines the interruptions have been the greater; but the electric roads did not suffer any more from the storms than did the steam roads. During the recent blizzard, traffic on some of the steam roads was completely interrupted for a time, and trains were hours late for several days. The conduit systems, such as those in New York city, were not troubled by breaking of lines, but a snow-storm, accompanied by a high wind, causes a good deal of trouble by partially filling the conduit with snow. It required the greatest effort to keep the lines in New York running during the blizzard—in fact, several of them were blocked for a time.

Telegraphic and telephonic communication within cities is now seldom affected by storms, and during the worst weather business can be carried on with but little inconvenience, even when the storm is so severe that few persons venture out on the street. For the country to become as independent of the weather as the cities it will be necessary either to place the wires underground or to make the lines so strong that they can defy the worst storms. The first alternative is impracticable on account of the cost, but in the latter direction much is being done. The overhead lines of electric railways are not as subject to these inconveniences as the telegraph and telephone lines, since, in general, the wires are heavier and more substantially put up. To avoid stoppages due to snow on the track, an ample equipment of plows and sweepers, with a good supply of power to keep them going, should answer all needs.

THE TANTALUM LAMP.

On another page of this issue we reprint a paper read before the Elektrotechnischer Verein, Berlin, on January 17, by Drs. W. von Bolton and O. Feuerlein, describing a new type of incandescent lamp which is about to be placed upon the market by the Siemens & Halske Company. This company has for many years past had experts at work searching for a material suitable to take the place of carbon in the ordinary incandescent lamp. As is well known, the incandescent lamp, while ideal in many ways, has a luminous efficiency much less than that of other types of electric lamps. The efficiency of an illuminant increases progressively with an increase in temperature, and by increasing the current through the carbon filament, almost any efficiency may be reached; but this greatly shortens the life of the lamp, for the carbon filament can not stand the higher temperatures.

To improve the lamp, and still obtain a satisfactory life, several lines of research have been followed. In one of these increased efficiency was sought by treating the carbon so as to enable it to withstand a high temperature, and with this object in view a coating of a carbide has been formed on the surface of the filaments. This seems not to have been successful, for the lamp was not offered for sale.

The success of the Nernst lamp and the incandescent gas lamps suggested another line of attack. It was thought that by impregnating the carbon filament with the oxides of the rare earths, a filament would be produced which would give an increased efficiency, due to the supposed selective radiation of these oxides. This attempt has not yet been successful.

A third way of approaching the problem was to seek for a material which might replace the carbon. This direction of research was the most obvious of all, but as the field was pretty thoroughly investigated at the time the incandescent lamp was first brought to a successful stage, the outlook did not seem promising. The first significant advance in this direction was the production of the osmium lamp, but this lamp has some serious disadvantages; the resistivity of osmium is comparatively low, and the material becomes soft at the high temperatures at which it is maintained. For these reasons the highest voltage for which the osmium lamp has been made is about fifty-five, and the filament is long, and, when lighted, resembles a piece of wet string, so that the lamps can only be placed in vertical positions. Another serious disadvantage of the osmium lamp is the rarity of the metal, and its consequent high price.

The tantalum lamp is the second important product of this third line of research. In it the short carbon filament is replaced by a much longer filament of the metal, tantalum. This metal has a fusing point higher than that of platinum, and it may be maintained at a temperature which gives it an efficiency greater than that of any other incandescent lamp. At the same time, a satisfactory life is obtained. To make a lamp for 110 volts, about two feet of tantalum wire approximately one-half millimetre in diameter is required. The efficiency is high, being about one and one-half watts per Hefner candle, or 1.7 watts per English candle.

Tantalum is not particularly rare, and as the amount of metal used in one lamp is exceedingly small, this item will not affect the cost of the lamp much. It is said that about 45,000 filaments can be made from one kilogramme of the metal. To make the filaments, the metal is drawn into thin wires, and this process, and that of obtaining the metal from its ores, will probably be the principal factors in determining the cost of the new lamp. Another trouble lies in the comparatively low resistivity of the metal. This makes necessary the use of a fine wire, which, as is shown in the paper, tends to draw itself up into globules when incandescent, on account of the surface tension. This action can not fail to decrease the life of the lamp, as it is probable that when once started it is progressive. As compared with the incandescent lamp, tantalum has a decided advantage, in that its resistivity increases with temperature, while that of carbon decreases. The metal filament is then self-regulating to a certain extent.

The method of supporting this comparatively long strip of wire described in the paper seems to give satisfaction. It would be interesting to know how these lamps are adjusted, as no stage of manufacture similar to that of flashing incandescent lamps is mentioned. It seems probable that the maker is depending upon securing a uniform quality of metal and a uniform size of wire, in which case no adjustment would be necessary, if the wire is cut accurately to length. Impurities have a marked effect upon the wire, increasing its resistance and decreasing its life. The purer the wire, the higher the temperature which it will withstand, and hence the higher its luminous efficiency, but the longer the filament must be. Marked progress may be expected in methods of producing the pure wire and of working it, and it is probable that the work in this direction will have the greatest effect upon the price of the new lamp.

It is instructive to notice how the new lamp is affected by conditions found most satisfactory with carbon filaments. To be commercially successful, the lamp must be suitable for at least 110 volts, and it must be of a size which will enable it to be used in our present fixtures—that is to say, about two feet of soft wire must be enclosed in a bulb little, if any, larger than that found satisfactory for protecting a few inches of carbon filament. Were this not the case, it is probable that a much larger bulb would be used. This would tend to increase the life of the lamp, and enable the wire to be spread out more, giving a more pleasant effect. With the present construction it is undoubtedly glaring and trying to the eyes.

The immediate field for the new lamp would seem to be in the lighting of large rooms and possibly for street lights. At the present time it is not practicable to make lamps of less intensity than about twenty-five English candles. This is rather large for use in small rooms. The standard in this country to-day is only sixteen candles, and even this is larger than is necessary. A lamp having half the intensity would probably give more satisfactory results.

So far as can be judged, the tantalum lamp seems to be the most important development in electric lighting since the Nernst lamp was brought out. The new lamp may be used on either direct or alternating-current systems. Its high efficiency means

practically the doubling of the available output of every electric lighting station. As experimental lamps have been in existence for about two years, it would seem that the maker is satisfied that the lamp is a commercial article. What every lighting station wants to know is, how much will these lamps cost, when can they be purchased, and in what quantities? It seems likely that it will be some years before the lamp can affect seriously the standing of the carbon filament lamp.

THE ELECTRICAL OPERATION OF TEXTILE FACTORIES.

The employment of electric driving in textile factories is not new in this country, as there are many noteworthy examples of mills which have abandoned steam or hydraulic power, pure and simple, for the electric motor. The success of the change has in all cases justified the expenditure, for the electric drive brings a great many advantages. Those who have not studied the problem closely will be likely to think that the only way in which a mill can gain by discarding the old steam system, with its ropes or belts, and putting in motors, will be by decreasing the cost of power; but this is not the only, nor chief, advantage. Indeed, it may happen that when due allowance has been made for depreciation and interest on the increased investment, the cost of power under the new will be little, if any, less than under the old system. The real gain lies elsewhere.

For a new factory a decision in favor of the electric drive gives a greater range in the choice of a site, for the mill itself is under no necessity of being immediately adjacent to the power-house, nor need it be on the water's edge, both of which conditions must be complied with if hydraulic power is adopted, and should also preferably be met when steam is used. But with the electric drive the power-house may be put wherever the best site is available, and the factory may be located elsewhere, its needs as a mill only being considered. This is a great advantage, for it may mean a considerable saving in the cost of the site, it may mean a healthier location, and it may bring immunity from stoppages due to floods.

In the factory itself the electric drive abolishes nearly all belting and ropes. The machines may then be located wherever best suits their individual requirements, they need not be placed at any particular point because the main line shaft passes over that point, nor need they all be operated with regard to the main drive, for it is usual to drive the separate machines from short lengths of shafting or by means of individual motors. As the belts are done away with, better lighting is secured, and hence better work results. At the same time there is less danger to the workers.

These are all important gains, but they do not represent the main advantages of the electrical drive; those which should have a greater influence than all the others in converting factory owners to the modern system. The most important gains from this point of view are the increased output of the factory and the improved quality of the product which are secured by the use of the electric motor. The greater steadiness of drive makes this possible through a higher average speed. At the same time the chance of breakdown is reduced. One or more sections of the factory may be run independently advantageously for special work or for overtime, and there is less loss of time in starting and stopping. Another incidental advantage of the electric drive is the possibility of future extensions, both of the power-house and of the factory, as this may be carried out with little reference to what has already been done. This is out of the question in a purely mechanically driven factory.

These advantages make a very respectable showing in favor of the electric drive, and should receive more attention than the mere question of reduction in cost of power. In fact, the cost of the power is only the smaller part of the total cost of operating a factory, though it is apt to be given undue prominence by the mill engineer, possibly because this is one item for which he is particularly responsible. The quality and quantity of the product, and the cost within the mill itself, are questions of management. As it happens, it is in these features that the effect of the electric drive is most felt.

A POSSIBLE DANGER TO HIGH-TENSION APPARATUS.

As is well known, when a brush discharge is brought about by a high electrical potential, ozone is formed, and this action has been made use of to produce ozone for commercial purposes. The formation of ozone by a brush discharge may, however, take place when it is not desired with consequent trouble. An incident of this kind is described in the London *Electrician* for January 27 by Mr. J. S. Highfield, who has had some difficulty due to the breaking down of the insulation of high-tension alternators under his charge. In the particular case mentioned the machine was designed for 10,000 volts, and was insulated with micanite tubes. Examination of the insulation showed the presence of both nitric acid and sulphuric acid, which had injured, and at some points eaten away, the insulating tape. The presence of the nitric acid is attributed to the formation of ozone, and the subsequent fixation of the nitrogen of the air; and this, uniting with the moisture held in the insulating material, formed nitric acid. The sulphuric acid was due to the action of the nitric acid upon gypsum, which was contained in the cloth insulation of the coils.

A somewhat similar trouble has been noticed in connection with high-tension cables. It has been found that the rubber of these cables deteriorates unless protected. The action is attributed to the formation of ozone, which directly affects the rubber. The formation of nitric acid under such conditions would probably not injure the rubber itself, but the acid would attack the lead sheathing, or any other metal with which it came in contact.

With an alternator conditions are different, for rubber insulation is seldom used, and ozone itself is not likely to injure the mica or cloth-insulating materials. To protect these, they must be kept free from moisture. It is probable that this is the reason why more trouble from this cause has not been experienced, for a machine under operation is heated more or less, and this tends to keep it dry. Should this drying action not be sufficient other means must be adopted, and that suggested in the paper is filling in the space around the conductor solid with some insulating material, thus excluding the air. Of course, air-blast or air-cooled transformers will be as liable to this action as alternators, while oil-insulated transformers are not.

SINGLE-PHASE MOTORS ON POLYPHASE SYSTEMS.

BY H. W. DOUBRAVA.

The comparatively recent action on the part of a number of prominent electrical manufacturers in bringing out a line of single-phase motors of the larger sizes is but a recognition of the increasing tendency among polyphase alternating-current central stations toward the single-phase development of their power business. The growth of this tendency has been very rapid, as is evidenced by the fact that from a general ruling of but a few years ago, that motors of one horse-power or less might be single-phase if the customer so desired, the rulings have changed so that now generally it is specified that motors up to and including certain sizes must be single-phase. These limiting sizes vary among the more progressive central stations from five to thirty-five horse-power. There are a number of central stations which go even farther and rule that nothing but single-phase motors can be connected to their lines, the generating plants themselves being polyphase. A great number of these changes in rulings has taken place practically within the last year, and in all cases were not determined upon without careful comparison of the advantages of both polyphase and single-phase power distributing systems.

As a general proposition, a comparison between a polyphase and single-phase plan of power distribution itself is very much in favor of the single-phase method for the obvious reason of simplicity and consequent saving in first cost and maintenance. On the other hand, up to the present time the development of a commercial single-phase motor for general power purposes has not reached the point where motors of fifty horse-power or larger can be readily obtained, necessitating the installation of polyphase motors of fifty horse-power or greater capacity, even where the installation of single-phase motors is carried to an extreme. At the first glance it would appear that single-phase and polyphase motors are competitive in sizes smaller than fifty horse-power, and will be for large sizes, as the art of building single-phase motors progresses, but the facts of the matter are that poly and single-phase motors are not competitive, and each type of motor has a distinct place of its own in the development and operation of a central station. The field for each motor is well defined, although no hard and fast rule can be laid down covering the exact sizes of motors which should be single-phase, and which would apply to any plant irrespective of size or local condition. In general, for a station of moderate size, single-phase motors of thirty-five or forty horse-power can be considered feasible and desirable and can be operated on the regular distributing circuits without fear of effects on line regulation. In the cases of smaller central stations, where the single-phase motor is of a large per cent of the generator capacity, it would be necessary to take into consideration the overlapping of the lighting and power load and the nature of the motor load. With a constant motor load, and with separate phase regulation, ninety per cent of the entire capacity of one phase of a generator might be taken up by a single motor without effect on the balance of the load fed from that phase. In a town of about fifteen thousand inhabitants there is operated on a two-phase sixty-cycle plant a twenty-horse-power single-phase motor driving a planer. The load on this motor varies from a third of its capacity to twenty-five per cent overload. This load is carried without any serious effect on the voltage of the station, even during the time when the motor load overlaps the lighting load. Generally speaking, a plant of this kind could readily take care of a single-phase motor of twenty-five to thirty horse-power, provided, of course, that the load did not vary between wide limits, and that the motor was not situated at the end of a long light line from which a number of lighting customers was supplied. Such a case, however, would be an extreme one, and it is doubtful whether the operation of any kind of an induction motor, poly or single-phase, could be accomplished with the best satisfaction.

The maximum size of a single-phase motor which can be operated on the lines of any station is so much dependent upon local conditions that an attempt to go fully into the matter would result only in endless detail, but in the majority of cases the limitations are more imaginary than real. Central stations which are operating single-phase motors of the larger sizes are experiencing no more trouble than the central stations that are extremely cautious and limit the maximum size to four or five horse-power, so that what seem to be objectionable features in large single-phase installations are evidently only apparently objectionable or are very easily overcome.

The principal reasons for opposing the connection of single-phase motors to polyphase lines are the effects of unbalancing and upon line regulation. The question of unbalancing is not worthy of serious concern, especially if the station is equipped as it should be, with the proper phase and feeder regulators and the proper arrangement of switching devices for throwing single feeders on any phase of the generators. Similar switchboard arrangements and feeder regulating arrangements are necessary, even for the regular incandescent or arc lighting loads. It will make no difference in the effect on the coal pile whether one phase is entirely loaded and the other absolutely without load or if both phases are equally loaded, and it will make no difference to the customer as long as the voltage is kept within reasonable limits. Extreme cases of unbalancing are far from probable and it should be as easy to keep the motor load balanced between the various phases as it would be to take care of the unbalancing of the regular lighting load. In the ordinary course of events, without any special attention being given to the subject, the chances are that as many motors will be connected to one phase as to another. The question of balancing, therefore, becomes one which is not serious and which can be very easily solved.

A comparison of the effect on line regulation between single and polyphase motors while running shows these effects to be practically the same for either case, as one single-phase motor on each phase will have the same effect as one polyphase motor having a capacity equal to the sum of the single-phase motors. Where the number of motors is considerable, as in the case of actual practice, a few more single-phase motors on one phase than on the other will not make an appreciable difference. In starting, a single-phase motor affects one phase; a polyphase motor, all phases. The general supposition is that a multiphase motor in starting affects all lines, but in a smaller proportion than a single-phase motor of the same size affects one phase, the proportion being in ratio to the number of phases. Single-phase motors, however, of the self-starting commutator type can be obtained on the market, which will be provided with a non-inductive starter, and start under full load with a starting current not greater than full-load current, and owing to the fact that the starting boxes are wound non-inductive, the power-factor of the starting current is very high. A comparative test made between a ten-horse-power, sixty-cycle, single-phase motor of the Wagner type, with a non-inductive starter and a seven and one-half-horse-power, two-

phase, sixty-cycle motor with an autostarter, showed the following results: the ten-horse-power, single-phase motor caused a drop in the primary line four and one-half miles in length and consisting of four No. 00 wires of 3.8 per cent in starting. The seven and one-half-horse-power starting with autostarter connected for medium torque caused a line drop of three and one-half per cent, or practically the same amount as that caused by the single-phase motor with the difference that the two-phase motor affected twice as many customers as did the single-phase machine. The power-factor of the single-phase motor starting current at the instant of starting was eighty-five per cent, and the two-phase fifty-five per cent. This same ratio held true for all sizes tested, so it was evident that with a proper design single-phase motors, and suitable feeder regulating arrangements, the single-phase motor will cause no more general effect than, if as much as, a corresponding polyphase machine.

With the demonstrated availability of suitable single-phase motors and their satisfactory operation on polyphase lines and station equipment arises the question of the advantages to be obtained from the use of single-phase motors. The idea of two wires only for lighting and power purposes is the ideal one, no matter whether this pair extends from the station itself, or from a passing polyphase feeder. A two-wire distribution is not only ideally simple, but is economical, both in first cost and maintenance. It would be almost impossible to make a general estimate of the saving of the single-phase over that of the polyphase system, or the saving to be made by a partial single-phase development, except, perhaps, in a newly laid out installation. The natural growth of any central station with its increasing load will complicate matters very materially, especially in the more congested districts. The taking on of a new customer often means the strengthening of the primary lines by addition of more copper. If the pole line is already crowded (as is usually the case) the question of finding room for additional conductors becomes very serious. Each individual case must be given separate attention and it is often necessary to strengthen the line a mile back, and the consequent rearranging of wires, additional cross-arms, pins, insulators, to provide room for the conductors, may be the principal expense in supplying a customer with current. Every additional wire means an increased cost in making room, a greater cost of pins, insulators and cross-arms, and a directly proportional increase in chances for grounds, crosses and short-circuits. Every polyphase motor installation means one or two more wires than would be necessary were this same installation single-phase. A central station man who has given the matter careful attention finds in actual practice that the cost of making room for a three-phase circuit varies from ten to fifty per cent for labor, and 0 to 25 per cent for material more than it does in the case of an equivalent single-phase installation. A great deal of the expense in making room can be saved by zig-zagging the new line in and out among the old ones, but no central station man can afford to add in any way to the complexity of pole-line wiring. The necessity of keeping the primary lines clear, and of being able to rapidly locate trouble, is of more than enough importance to warrant the simplest and most easily traced form of construction, even at an increased first cost.

The one place in which a polyphase distributing system shows a saving is in copper. A three-phase transmission theoretically takes twenty-five per cent less copper than four wires two-phase or single-phase system. It does if the size of copper can be made to meet exactly what is required for the load. Even if the exact requirements can be met as far as the copper is concerned, a saving of twenty-five per cent in cost of the conductors can not be obtained for the reason that the insulation of the conductors themselves must enter into the calculation. Below is a table giving the relative weight of conductors to carry a given load, single-phase, and to carry the same load, three-phase, allowing twenty-five per cent less copper for the three-phase transmission. Comparative weights are also given of the bare copper itself. The figures in this table are based upon a thousand-foot transmission line:

No. of Wires.	Size of Wire. No.	Weight Triple Braid Weatherproof Wire. Lbs.	Weight of Bare Copper. Lbs.	Saving in Weight.		Per Cent Actual Saving.	Per Cent Saving Copper.
				Weatherproof T. B. Wire. Lbs.	Bare Copper. Lbs.		
2	00	980	806	....	....	....	....
3	2	804	606	172	200	17.5	24.8
2	0	800	640	....	....	....	....
3	3	630	477	170	163	21.2	25.5
2	1	612	506	....	....	....	....
3	4	492	378	120	128	19.6	25.3
2	2	536	404	....	....	....	....
3	5	435	300	101	104	18.8	25.7
2	3	420	318	....	....	....	....
3	6	336	237	84	81	20.0	25.5

From the above table it becomes very evident that while there is a saving of twenty-five per cent in copper there is not a saving of twenty-five per cent in dollars and cents. The same comparative table might be made out for a three-wire, two-phase transmission, and the figures would show up even less in favor of the polyphase line, and the comparison between a four-wire, two-phase and a single-phase transmission will show less cost for the single-phase. Again, good practice does not permit of the use of smaller wire than No. 6, and a pair of No. 6 wires is often all that is required to carry the load. Consequently, instead of there being a saving in wiring there is often actually an increase in the cost of copper of from fifty to one hundred per cent for a polyphase over that of a single-phase line answering the same purpose.

In the outlying districts where long runs must be made to pick up customers the field is distinctly that of the single-phase motor. No central station man wants to extend a long polyphase line for the purpose of picking up a small polyphase customer, much less extend an additional phase in order to supply him. These extensions in many cases make it a question as to whether it is at all advisable to take on even a desirable customer on account of the high cost of extending additional phases. The best proportion of load in the outlying districts will be for lighting purposes, which can not be connected polyphase, so that there is no question but that for the outlying or even for the intermediate districts the simplest, cheapest and most flexible arrangement would be a single-phase system of distribution.

A general comparison between the two systems in question can be summed up about as follows: for polyphase motors there is a saving incurred in copper in three-phase transmission lines where the current is larger than can be carried by a pair of No. 6 wires, and the question of phase balance is somewhat simplified. For single-phase motors, the advantages are its simplicity, less liability of grounding, savings in pins, insulators, cross-arms,

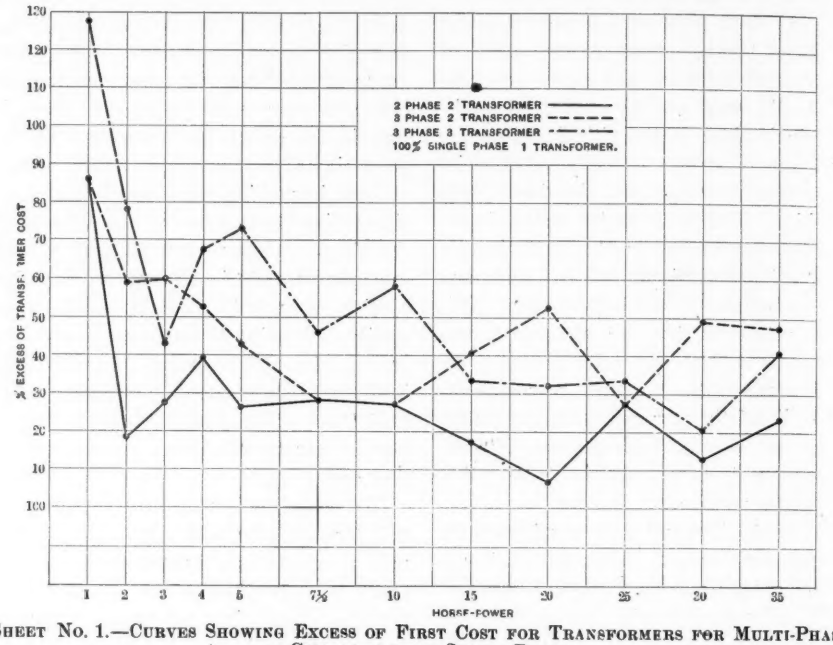
saving in cost of primary conductors where No. 6 wires are large enough to carry the current, and in the case of a two-phase, four-wire transmission line, saving in extra phase extension to take on new power customers and less depreciation.

It will often be found that the central station man will take the position that because the polyphase line runs past the door of his customer, that naturally a polyphase motor should be installed, even though the motor be no larger than ten horse-power. While it is hard to get an approximate line on the saving to be obtained by the use of single-phase motors as far as the primary line cost is concerned, it is not so difficult to get a fairly close estimate on the saving between the point at which the current is taken from the line and the motor itself. Basing calculations upon the supposition that a polyphase would take two transformers and a single-phase motor one, the cost of labor and material in connecting the primaries of the two transformers will be twice that for one. The labor of erecting two transformers would be from ten to one hundred per cent more for two converters than for one. If there is perfectly clear sailing ten per cent extra will pay for the labor. Often, however, one transformer may be hung from the cross-arm at the pole, where, if two transformers are erected at the same point, either an additional cross-arm must be put up or the original one considerably strengthened. Again, one transformer may be hung without disturbing the general arrangement of the wiring already in place, while the erecting of two may mean entire rearrangement in order to make room. Therefore the estimate of ten to one hundred per cent extra for the erection of two transformers, which is based upon actual observation, is undoubtedly quite conservative. The wiring from the transformer to the service switch, which is part of the expense that must be incurred by the central station, will be anywhere from one to fifty per cent more expensive for a polyphase motor installation. In case of a three-phase motor the saving in copper will about balance the cost of extra labor. However, where there is considerable special work to be done, such as turning corners, crossing over, etc., a great number of additional pins and brackets will in many cases increase the cost fifty per cent.

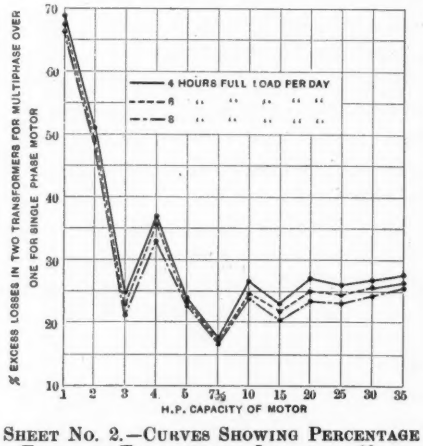
The extra cost of meters will vary according to the policy of the company. If two meters are used the extra expense of labor and meters will amount to nearly sixty per cent. If polyphase meters are used the meters themselves will cost about fifteen per cent more and labor about ten per cent, owing to the more complicated wiring and time expended in tracing out connections.

For installations of one horse-power or more the extra cost for transformers themselves will vary from eighty per cent for the smaller installations to twenty per cent (see curve sheet 1) for the larger; that is, provided there are available transformers of exactly the right size in the storeroom. In addition to this, it will be necessary to keep a larger stock of transformers of smaller, therefore more undesirable size, which means greater investment with its accompanying interest and depreciation charges. The same objection applies to meters, as either more or two kinds of meters must be carried in stock to provide for polyphase motor installations.

There is also an increased loss in transformers due to the fact that the loss in two transformers is greater than the loss in one, which is equivalent in capacity to the sum of the two. The following table based upon the advertised losses of a well-known type of transformer will show the increased losses in the transformers. Curve sheet No. 2 shows the increased loss in watts figured upon the basis of a motor running eight, six or four hours per day at full load, demonstrating that these excess losses do not depend so much on the amount of load as upon the kind of motor installed:



SHEET NO. 1.—CURVES SHOWING EXCESS OF FIRST COST FOR TRANSFORMERS FOR MULTI-PHASE AS COMPARED WITH SINGLE-PHASE.


4 HOURS FULL LOAD PER DAY
% EXCESS LOSSES IN TWO TRANSFORMERS FOR MULTIPHASE OVER ONE FOR SINGLE PHASE MOTOR
H.P. CAPACITY OF MOTOR

SHEET NO. 2.—CURVES SHOWING PERCENTAGE EXCESS IN TRANSFORMER LOSSES FOR MULTI-PHASE AS COMPARED WITH SINGLE-PHASE MOTORS.

H. P.	Watts Excess Copper Loss.	Watts Excess Core Loss.	H. P.	Watts Excess Copper Loss.	Watts Excess Core Loss.
1	18	25	10	42	42
2	16	25	15	30	48
3	3	18	20	41	64
4	22	26	25	55	70
5	28	24	30	72	78
7½	30	14	35	94	85

For example, take the number which is opposite the horse-power of the motor that it is desired to operate, which is in the first column of figures, corresponding to copper loss, and multiply it by the average number of hours at which the motor operates daily, and divide this number by twenty-four. To this quotient add the number which is in the last column of figures, corresponding to core loss, and opposite the horse-power of the motor in question, and the resultant number will

be the watts lost by operating this particular motor polyphase instead of single-phase.

Cost per Kw.Hour.		Cost per Kw. Hour.	
$0.005	.0428	$0.0175.....	.1533
.0075	.0657	.02	.1752
.01	.0874	.0225.....	.1971
.0125	.1090	.025	.2190
.015	.1314		

Take this number of watts and multiply it by the number in the second column which is opposite the cost per kilowatt-hour of the current produced by the central station, and the amount will represent the actual extra cost of the additional losses. Divide the amount by 0.05, and the result will represent the amount of extra investment at the rate of five per cent, and should be added to the other expenses incurred in the erection of two transformers instead of one.

Taking the question as a whole, there is no place in the whole scheme of central station distribution wherein the installation of single-phase motors within the limit of the practicability will not put money in the pockets of the central station man. While polyphase circuits are necessary for large motor installation for long transmissions to substations and to rotaries, at the same time the single-phase motor has a very large place in the economy of central station development, and its importance can not be underestimated. A great many of these facts are perhaps quite familiar to the average central station man, but in a great many cases the subject is dismissed without even a partial action on their part to take advantage of the very material saving to be gained by the judicial development of single-phase installations. Single-phase motors are no longer in the experimental stage, and motors of this class, which in actual operation are the equivalent of polyphase motors in efficiency and power-factor, and which will develop very high starting torque and are amenable to the same starting current control as polyphase motors, have been on the market for seven or eight years. These machines have been in operation long enough to fully demonstrate their reliability, and single-phase power distribution is no longer a question of theory or experiment. With all its obvious advantages it can not be said that it is good business policy to make an extra investment of from twenty-five per cent to seventy-five per cent of the value of the motor itself in order to furnish power to a polyphase motor, nor can the fullest returns be expected for the money invested in power stations if advantage is not taken of every possible saving and if every development is not made with the idea of adding to the simplicity of the distributing system.

Street Railway Conditions in Massachusetts.

During the year ending September 30, 1904, of seventy-four companies operating street railways in Massachusetts, thirty failed to earn expenses and fixed charges; twenty-five paid dividends; of the twenty-five which paid dividends, fourteen earned them during the year. Five companies have been in the hands of receivers.

Very few companies besides keeping their railways in good repair reserved for depreciation what prudent management would require. Generally present necessities only have been met, the future with its inevitable expense of replacement and reconstruction being allowed to look out for itself.

The board of railroad commissioners of Massachusetts prepares a yearly list of companies which appear from its returns to have properly earned and paid a dividend of at least five per cent for the five years immediately preceding. Thirteen companies were found to be entitled to a place upon the list submitted in January, 1903; the list of January, 1904, contained the names of twelve companies; that submitted this year contains the names of ten companies.

Experience has shown that with the more expensive roadbed and equipment, the heavier rail and larger cars, there has not been the corresponding and expected development of permanent business. Operating cost, in heating cars and in repair and renewal of plant, has proved larger than was expected. With the new accommodation and the nearer approach to railroad conditions has come the increased demand of the public for expenditures in the interest and safety and comfort which had not been counted upon, as for example, in construction of double track, instalment of signal systems and establishment of waiting rooms.

Upon some railways fares have been raised, and with encouraging results, but this action is usually unpopular and is often taken at the risk of lessening the volume of business. It is, moreover, at times complicated by agreements made between companies and town officials when locations and privileges in the streets were granted.

Another incident of the present situation has been the enforcement upon certain systems of a seemingly arbitrary distinction between the long and the short-distance ride, to the provocation of the through traveler, who is loath to admit that there is any justification for it. The zone system has never been favored in Massachusetts. Instead there has been adopted the five-cent fare within city and town limits, in some cases between centres of adjoining towns. As new grants of location have been sought the five-cent fare has been made good for greater and greater distances, frequently through the use of transfer checks. This low fare promotes a better distribution of population in large communities and is now conveniently paid and collected, while the company has been enabled to reap a profit in the frequency with which cars have been filled and refilled with persons taking short rides. In one notable and exceptional instance this fare covers five cities, which were deemed to be so closely connected as to make practically one continuous community, and so to give the company the advantage of continually changing patronage from point to point. The attempt, however, upon interurban lines to maintain these local concessions and at the same time to establish a sort of mileage basis for through travel, with arbitrary fare limits, has naturally led to frequent complaints from those who think they are unjustly denied privileges which are given to others. Much study has been and is being given to the establishment of a more satisfactory system of fares upon these railways, but as yet the problem remains unsolved.

The following is a table of statistics for 1904 and the preceding year:

Year Ended Sept. 30.	1904.	Changes from 1903.
Mileage single track.	$2,724,312	Inc. $53,580
Gross assets.....	140,843,740	Inc. 1,979,525
Gross liabilities	136,049,486	Inc. 2,928,075
Capital stock.....	68,542,038	Inc. 137,558
Funded debt.....	46,674,884	Inc. 5,263,384
Current liabilities...	17,434,432	Dec. 2,547,059
Surplus.....	3,152,868	Dec. 976,952
Gross earnings	26,207,247	Inc. 666,430
Operating expenses.	18,397,291	Inc. 877,924
Net earnings.....	7,809,956	Dec. 211,488
Dividends	3,214,496	Dec. 371,752
Interest, taxes and charges.....	6,363,830	Inc. 358,462
Surplus for year....	*216,383	Dec. 233,051
Passengers carried..	520,056,511	Inc. 15,394,268

* Deficit.

A new electric railroad is soon to be constructed in Alsace, in the neighborhood of Munster. It will start from the latter town and pass by Stoswihr, with the terminus at Schlucht. Part of the road lying near the terminus passes up a steep grade, so that it is necessary to use a rack-and-pinion system over this part, which runs from Altenbach to Schlucht. It is estimated that the total distance will be covered in fifty-five minutes. The line is situated near the French frontier, so that it is expected to make connection with the railroad on the French side.

BOOK REVIEWS.

"Telephone Service." Herbert Laws Webb. New York. The Macmillan Company. Paper. 118 pages. 5½ by 8¼ inches. Illustrated. Supplied by the ELECTRICAL REVIEW at 40 cents.

This book describes in popular language the history and mechanism of the telephone. It deals with the troubles of the central operator, and the treatment which should be accorded central by the subscriber.

"Self-Propelled Vehicles," a practical treatise on the theory, construction, operation, care and management of all forms of automobiles. Second edition. James E. Homans. New York. Theodore Audel & Company. Cloth. 652 pages. 6 by 8½ inches. Many illustrations. Supplied by the ELECTRICAL REVIEW at $2.

Books which have heretofore appeared on this subject have been, with few exceptions, of an amateurish character, consisting largely of a compilation of trade publications, or else written with second-hand inspiration derived from some manufacturer of a particular type or class of machine. A book has at last appeared, however, that is all that, and more than it claims to be in the preface. The subject matter is well presented and the book will be a welcome volume to all those interested in automobile topics. After first giving a brief history of the self-propelled vehicle, the author takes up the general requirements common to all classes of automobiles, such as steering gear, running gear, brakes, bearings, tires, wheels, etc. A clear and comprehensive treatment of the internal combustion engine follows in which the author outlines the theory, construction and operation of this type of motor, and also gives some methods of testing. The various auxiliaries for gasoline motor carriages are then discussed, after which the author gives descriptions of some of the best known cars. In that part of the book devoted to the electric carriage, there is included an explanation of the electrical units and their relationship; the action of the storage battery is discussed and points on the care and operation of batteries are given that will be of value to the users of the electric carriage. The last part of the book is devoted to the steam car in which the author outlines the principle of the steam engine; after a short discussion on boilers a description of some of the representative types of engines is given.

"Electricity in Every-Day Life." In three volumes. Edwin J. Houston. New York. P. F. Collier & Son. Cloth. 5½ by 8 inches. 584, 566 and 609 pages, respectively. Illustrated. Supplied by the ELECTRICAL REVIEW at $5.

Dr. Houston needs no introduction to the electrical student. His writings are always clear and entertaining and, above all, accurate. In these books he has given a full discussion of the applications of electricity in all of its many uses. The style of the work is such that any one can read it understandingly. Vol. i, after calling attention to the importance of the electrical industries in an introduction, takes up the history of the science and tells practically everything the ordinary reader need know about electricity. Indeed, if any one goes through this work carefully, he may consider himself well posted in elementary electrical science. The first volume is entirely given up to the science, and this, it is a pleasure to see, has been brought up to date. Vol. ii takes up, first, electrochemistry and electrometallurgy, describing the earlier laboratory experiments and the commercial apparatus which is the product of the last few years. The telephone is then treated in the same way, the earliest work of Bell, Edison and others being given impartially. The latest systems are described. Next telegraphy is considered, including wireless systems. This is followed by a description of fire-alarm, burglar-alarm and other calling systems. Electric heating comes in for the next consideration. Under this head are described cooking appliances, electric welders and other devices of a similar nature. Vol. ii closes with a brief dissertation on electrotherapeutics. In vol. iii the theory of the dynamo and dynamo construction is discussed. This is followed by electric lighting; arc and incandescent lamps and lighting generators are described. Following this the newer types of lamps are described, and their operation explained. The volume closes with a discussion of the applications of the electric motor to general purposes, and to the operation of electric railways. There is also a discussion of the electrical transmission of energy. As will be seen from this summary, the three volumes form a very complete review of the electrical science and its applications. Throughout the volumes side-headings guide one in the search for particular information. The typographical work is good, but it is to be regretted that a better grade of paper was not used. There are many illustrations, some of the half-tones being excellent, and each of the three volumes has a frontispiece in three colors, that of vol. i being a photograph of Thomas A. Edison in his laboratory. The other cuts, however, are far from what they should be, and in many cases are distinctly bad. It is a great pity that the work was spoiled by the use of these old woodcuts and half-tones. The text is certainly worth better illustrations.

"Telephone Principles and Practice." George Walker Wilder, Ph. D., assistant professor of electrical engineering at Armour Institute of Technology. Madison. Cantwell Publishing Company. Cloth. 450 pages. 375 illustrations. Supplied by the ELECTRICAL REVIEW at $2.

Books upon telephonic subjects are numerous. Yet, strange to say, the idea is prevalent that the telephonic science is without satisfactory literature. This is true, and there are several reasons for it. The science is young, that is, freedom of expression is such a new liberty, and the old habit of silence so strong, that nothing can be expected from those who could write volumes of valuable stuff. Then the development has been rapid. However, this has proved no bar to clever and comprehensive text-books in electrical engineering. Another reason, there is as yet a scarcity of that chronic and prolific class of text-book writers known as college professors. Nearly all telephonic books up to date have attempted to reach both the beginner and the more experienced man as well. Consequently there are two classes complaining. To try to reach both reaches neither. No text-book will be successful, aside from financial considerations, until the beginner, or ordinary telephone worker, is separately guided from the widely experienced worker. The student needs a simple, concise and brief explanation, with nothing taken for granted, with things presented in logical order, so that the mind will acquire a momentum, carrying it far beyond the book. If, however, he finds too much taken for granted, explanations complex, and no logical order, he will lag, and the book will be thrown aside. It is plain that "Telephone Principles and Practice" is the work of a teacher. The book is an echo of the class work. Doctor Wilder starts in with a definite idea; that of handling the beginner. He gives the beginner brief, concise and simple explanations, the matter is presented in logical order, and at no time is there confusion. First, the fundamental ideas of telephony; second, the apparatus used in exchange service; third, the different methods of communicating between subscribers, and fourth, construction and equipment. The first and fourth parts are well presented, while the second and third, although nicely presented, strongly suggest company bulletins. On the whole the book is worthy of attention from all telephone men. For the exchange operator no other book presents as much helpful information.

THE TANTALUM LAMP.[1]

BY DR. W. VON BOLTON AND DR. O. FEUERLEIN.

PART I—BY DR. W. VON BOLTON.

While the carbon filament incandescent lamp remained for nearly two decades the sole representative of glow lamp manufacture, progress was being quietly made in this art. The firm of Messrs. Siemens & Halske has for many years been working at a solution of an economical incandescent lamp, and arrived some time ago[2] at the fundamental principle that the visible part of the radiation of an incandescent body increases progressively with its temperature. This warrants the postulate that the most economical lamp will be that whose incandescent material will withstand the highest temperature.

Messrs. Siemens & Halske had arrived at this conclusion and charged me several years ago with the task of discovering a material which should have a melting point considerably above the temperature at which incandescent lighting becomes highly economical, so that filaments made of such a material would not melt or disintegrate at that temperature. While our laboratory work, founded upon this idea, was going on, the first two advances in incandescent lighting were made public, one being the "Nernst" and the other the "Osmium" lamp.

There are certain metals the melting points of which are known to be considerably above 2,000 degrees centigrade, and the task resolved itself into finding one which, while fulfilling the above requirement, could be easily worked to form a filament, and not be very rare or difficult to procure. It was early observed that brown vanadium pentoxide, which, according to Berzelius does not conduct electricity, is, as a matter of fact, a conductor even when cold. This observation induced me to try whether vanadic acid could not be electrolytically decomposed. In this I succeeded, but the melting point of the vanadium obtained proved too low for the purpose in view. Since the metals niobium and tantalum are members of the vanadium group, niobium having an atomic weight double that of vanadium while the atomic weight of tantalum is double that of niobium, it was thought that one or both of these metals might prove to have the desired qualities. On experimenting with niobium on the lines adopted for vanadium, it appeared that this metal has a considerably higher melting point than that of vanadium, but not, however, sufficiently high; moreover, some of the niobium filaments which I made had a very strong tendency to break up when heated by the electric current.

Tantalum was tried next. I reduced potassium tantalo-fluoride in the manner prescribed by Berzelius and Rose and found that the finely divided tantalum so produced became fairly coherent on rolling, so that by this treatment metallic strips of it could be made. It was also attempted to work tantalum oxide into the shape of a filament by mixing it with paraffin and to reduce it directly into the form of a metallic thread. In these experiments there was observed for the first

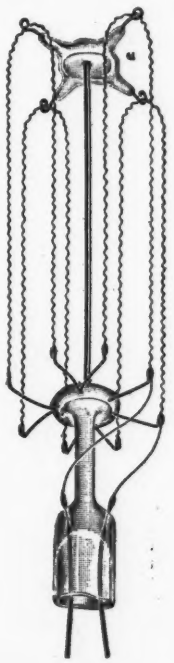


FIG. 1.

time a minute globule of molten tantalum, and this globule was of sufficient toughness to permit hammering and drawing into wire. Following out this observation, tantalum powder was melted in a vacuum, and then it was found that the highly heated metal parted with the gases it contained. In this manner I produced my first filaments of pure metallic tantalum, which were, however, very small. When these had been used in lamps with promise of good results, an attempt was made to devise a definite process of purification. The potassium tantalo-fluoride was reduced to metallic powder; this powder contains a small proportion of oxide and of hydrogen which is absorbed during the reduction. When the powder was melted in a vacuum the oxide and absorbed gas disappeared, and a reguline metal remained; on carefully remelting this it became so pure that no appreciable impurities could be detected in it.

The chemical properties of this pure tantalum are very remarkable, and some of them are of such a nature as to lead me to suppose that nobody other than myself has ever had metallic tantalum in his hands. When cold, the material strongly resists chemical reagents; it is not attacked by boiling hydrochloric acid, aqua regia, nitric acid or sulphuric acid, and it is also indifferent to alkaline solutions; it is attacked solely by hydrofluoric acid. Following the behavior of steel, when heated in the air it assumes a yellow tint at about 400 degrees centigrade, and the tint changes to dark blue when the tantalum is exposed for some time to 500 degrees centigrade, or for a shorter time to 600 degrees centigrade. Thin wires of the substance burn with low intensity and without any noticeable flame when ignited. It absorbs hydrogen as well as nitrogen with great avidity, even at a low red heat, and forms with them combinations of a metallic appearance, but rather brittle. It combines with carbon very easily, forming several carbides which, as far as they are at present known, are all of metallic appearance, but also very hard and brittle. The product which Moissan thought to be tantalum was clearly a carbide of this nature or an alloy of a carbide with pure tantalum, for Moissan himself stated that his metal still contained one-half per cent of carbon. Considering the high atomic weight of tantalum (183) it is obvious that a very small quantity of carbon suffices to carburize a relatively large quantity of tantalum. This view of the constitution of Moissan's product is confirmed by the properties he ascribed to the metal—namely, specific gravity 12.8, great hardness and brittleness. These are not properties of pure tantalum. When in the form of powder, still containing, as previously stated, oxide and hydrogen, the specific gravity of my material is about fourteen; when purified by fusion and drawn into wire it has a specific gravity of 16.8. It is somewhat darker than platinum, and has a hardness about equal to that of mild steel, but shows greater tensile strength than steel does. It is malleable, although the effect of hammering is relatively small, so that the operation must be rather long and severe to beat the metal into a sheet. It can be rolled, as well as drawn, into a very fine wire. Its tensile strength as a wire is

[1] Translation (through the courtesy of Mr. Alexander Siemens) of a paper read before the Elektrotechnischer Verein, of Berlin, on January 17. Reprinted from *Electrician*, London, January 27.

[2] *Cf.* W. Siemens in *Elektrotechnische Zeitschrift*, vol. iv, p. 107, 1883.

remarkably high, and amounts to ninety-five kilogrammes per square millimetre, while the corresponding figure for good steel is seventy kilogrammes to eighty kilogrammes, according to Kohlrausch.

The electrical resistance of the material at indoor temperature is 0.165 ohm for a length of one metre and a section of one square millimetre (specific conductivity as compared with mercury 6.06). The temperature coefficient is positive, and has a value of 0.30 between 0 degrees centigrade and 100 degrees centigrade. At the temperature assumed by the incandescent filament in the lamp at 1.5 watts per candle-power, the resistance rises to 0.830 ohm for a length of one metre and a section of one square millimetre. The coefficient of linear thermal expansion between 0 degrees centigrade and sixty degrees centigrade is 0.0000079, according

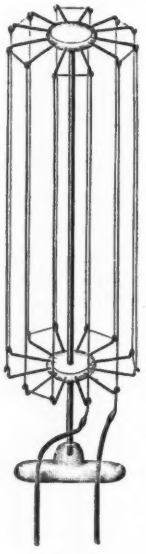


FIG. 2.

to experiments made by the Imperial Normal-Aichungs commission. Fusion is preceded by a gradual softening, which appears to extend over a range of temperature of several hundred degrees. The specific heat is 0.0365, so that the atomic heat is 6.64, which is in accord with the law established by Dulong and Petit.

PART II—BY DR. O. FEUERLEIN.

The results of the work carried out in our chemical laboratory, as described by Dr. von Bolton in the first part of this paper, were, of course, of the utmost interest to our incandescent lamp manufacturing department. As soon as Dr. Bolton's experiment showed that the originally brittle tantalum could be made ductile enough to draw into wire by the usual methods, and that this wire could be bent and coiled like a thin steel wire, it became possible to test it thoroughly as to its usefulness for incandescent lamps. The first trials with wires of about 0.3 millimetre diameter gave most promising results. They confirmed the fact that

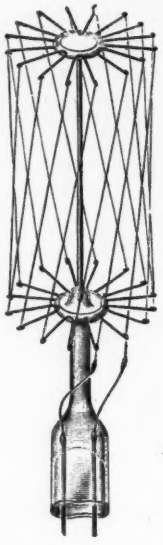


FIG. 3.

tantalum has a very high melting point, and that it is but slightly subject to disintegration in a vacuum, even when subjected to a heavy current.

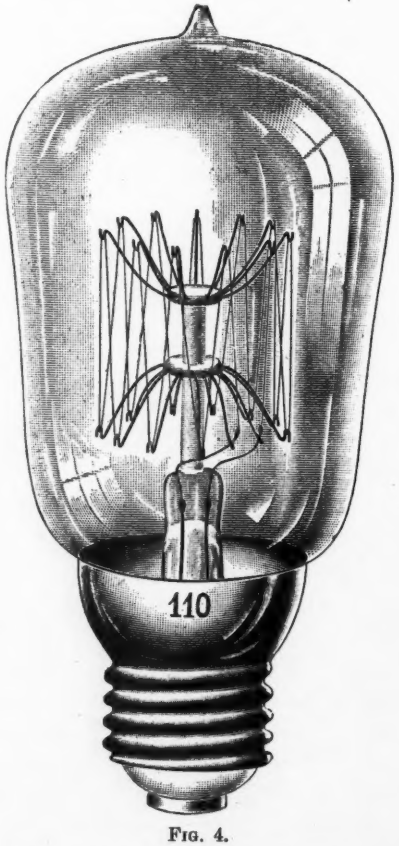


FIG. 4.

The first tantalum lamp has proved moderately satisfactory in that it admitted of an exact measurement of the electric and photometric conditions and stood a burning test for some time, was completed just over two years ago—*viz.*, on December 28, 1902. This lamp had a loop-shaped filament made of the first tantalum wire ever drawn. The diameter of the wire was 0.28 millimetre, its effective lighting length fifty-four millimetres and its electrical resistance when cold 0.29 ohm. This corresponds to a specific resistance (one metre length, one square millimetre section) of 0.331. The photometric measurements made at efficiencies of two, one and one-half and one watt per Hefner candle-power showed potential differences of 4.9, 4.95 and 5.9 volts, currents of 5, 5.46 and 6.2 amperes, and illuminating values of eleven, eighteen and thirty-seven Hefner candle-power respectively. On being burned at one watt per candle-power the lamp had a life of twenty hours, during which it blackened considerably.

As the chemical and mechanical manufacturing process developed and the material became purer and the wires more uniform, the results obtained also improved. The lamps lasted longer and

FIG. 5.

blackened less; at the same time the specific resistance decreased until it had dropped to the present figure of 0.165 for the pure metal. It is clear that the material used for the first lamps still contained a considerable quantity of impurities, probably niobium and carbides, which caused the great disintegration and the nearly double specific resistance. During these first trials we looked very carefully into the question as to what dimensions the filament of a tantalum lamp ought to have for ordinary voltages and illuminating values. From the dimensions of the filament used in the first lamp we calculated that, with this rather impure material, we should require a filament about 520 millimetres long and 0.06 millimetre diameter for a lamp for 110 volts, thirty-two Hefner candle-power and 1.5 watts per candle-power. These unusual figures increased when the specific resist-

ance of the material had diminished to the present value of 0.165, at which for a thirty-two Hefner candle-power lamp, a filament of about 700 millimetres in length by 0.055 millimetre in diameter was required; for a twenty-five Hefner candle-power lamp, a filament of about 650 millimetres by 0.05 millimetre diameter was required. Thus, in order to construct a practical and useful lamp for standard voltages and illuminating values, we had to solve the problem of drawing the tantalum wire in sufficient length down to a diameter of 0.05 millimetre to 0.06 millimetre; this we succeeded in doing after long and laborious trials.

In July, 1903, we possessed the first tantalum lamp with a filament of about 0.05 millimetre diameter. It had a loop-shaped filament fifty-four millimetres long and it took 0.58 ampere at nine volts and gave 3.5 Hefner candle-power at 1.5 watts per candle-power. On the basis of these figures a lamp having the same quality and diameter of wire and working at the same efficiency on a 110-volt circuit would have a filament 650 millimetres long and would give forty-three Hefner candle-power. The experiments thus far had proved that the task of producing lamps for 110 volts and a maximum of 25-32 Hefner candle-power was not an easy one in several respects. We had to solve the problem of suitably and reliably fixing a filament rather more than two feet long within a glass globe which should not exceed to any great extent the dimensions of the usual incandescent lamps. The first and most obvious attempt was made, of course, by adhering to the loop shape and accommodating the required length of wire by connecting several such bows in series within the lamp. However, lamps made according to this plan with two to four tantalum loops gave results which were anything but satisfactory.

It appeared that, like all other metallic filaments which have hitherto been used for incandescent lamps, tantalum wire softens sensibly at the temperature attained when worked at 1.5 watts per candle-power. To use loop-shaped or spiral filaments similar to the carbon filaments of the common incandescent lamps was, therefore, out of the question. There was no difficulty in suspending the loops, but in that case the lamps would have to be used exclusively in a vertical position, a limitation which we wished to avoid in all circumstances. Besides, such a construction would necessitate staying the loops firmly to prevent them from becoming entangled with each other during transport of the lamps. Nor did lamps made with loops of corrugated wire (Fig. 1), or of plain or corrugated metal ribbon give satisfaction; for although the loops were certainly shortened in this way, there were other drawbacks which caused us to abandon this construction. It soon became apparent that the one road to success lay in the direction of dividing the filament into a number of short straight lengths supported at their ends by insulated holders. In this manner we succeeded at last, in September, 1903, in producing the first really serviceable lamps for about 110 volts. This lamp is illustrated in Fig. 2, and it will be seen that it contains two glass discs cast to a central wire holder; each disc carries laterally twelve arms having small hooks at their ends and insulated from each other. Through these twenty-four hooks the thin tantalum wire is drawn up and down between the two discs. This is believed to be the first metallic incandescent lamp for nearly 110 volts which, like the common carbon glow lamp, can burn in any position whatsoever. This lamp supplied about thirty Hefner candle-power on a ninety-four-volt circuit at 1.5 watts per candle-power. It lasted for 260 hours and lost during that time 9.5 per cent of its illuminating power.

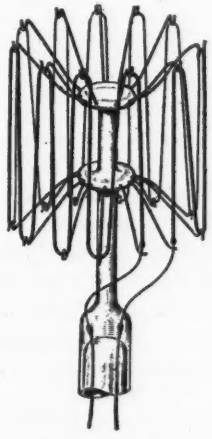


FIG. 6.

After this first practical success we redoubled our efforts to improve the lamp further. As far back as about the middle of October, 1903, we succeeded in making the first 200-volt tantalum lamp, which was of a design similar to the lamp just described, but with eighteen arms on each disc and with a greater distance between the two discs. I may add at once that it is of interest only as a curiosity, for it has served no practical purpose. The length of its filament was 1,350 millimetres and the illuminating value about sixty Hefner candle-power. In the course of further development the form of the frame of wire filament for the 110-volt lamp went through different stages, the principle of subdivision being always followed. Among other constructions we tried some in which, instead of one long filament, a number of short pieces of wire were fixed on a supporting frame; these pieces, connected in series, made up the total length required. Fig. 3 represents a lamp thus constructed, the wire being fixed obliquely in sixteen straight pieces between two insulated supporting stars. Such lamps offer the advantage that short pieces of filament can be used in the manufacture. But they are only reliable if the wires used in the same lamp are absolutely uniform in diameter and quality. In the end we arrived at the shape represented in Fig. 4, which is for 110 volts, twenty-five candle-power and 1.5 watts per Hefner candle-power. In this form, differing from most of the previous constructions, the central support consists of a short glass rod carrying two discs, into which the arms, bent upward and downward in the shape of an umbrella, are cast. The upper star has eleven, the lower twelve arms, each upper arm being in a vertical plane midway between the vertical planes in which two adjacent lower arms lie. Between these eleven and twelve arms, which are bent into hooks at their ends, the entire length of the filament is drawn in a zigzag fashion. Its extremities, held by two of the lower arms, are connected with the foot of the lamp by means of platinum strips.

The standard type for 110 volts twenty-five Hefner candle-power and 1.5 watts per candle-power has a filament 650 millimetres long and 0.05 millimetre in diameter. The weight of this filament is 0.022 gramme, so that about 45,000 lamps contain together one kilogramme of tantalum. The shape of the glass globe is adapted to the frame described above. Care has been taken to make it of a size not exceeding the usual maximum dimensions of common incandescent lamps of the same candle-power (twenty-five Hefner candle-power 110 volts). This shape offers a number of noticeable advantages. In the first instance it is very stable and will stand strong shocks without damage to the lamp. A considerable number of such lamps sent across the sea to test their ability to withstand the hardships of transport came back unhurt, although they had been packed just like common glow lamps, and no special care in any respect had been taken in their handling. The lamp burns, of course, in any position, and can therefore be held

in any kind of fitting. The light is rather white and agreeable, and its effect is particularly uniform if the lamp is provided with a ground-glass globe.

We shall now proceed to describe the electric and photometric properties of the lamp and its behavior in actual use. Numerous trials for lengthy periods of time at one to three watts per candle-power have proved the vast superiority of the tantalum lamp over the carbon filament lamp under equal electric and photometric conditions. Expressing this fact in figures, we can state that the tantalum lamp consumes about fifty per cent less current at the same voltage, with the same intensity of light and the same useful life; or that, at the same economy, its life is several times that of the carbon type. Moreover, at an initial efficiency of 1.5 volts per Hefner candle-power the tantalum lamp has an average life quite sufficient for all practical requirements, so that this rating has been standardized for the 110-volt lamp. Trials have also proved that the lamps have a life of several hundred hours at one watt per Hefner candle-power, but in that case they were very sensitive to variations of pressure and often showed an early decrease of illuminating power. The useful life of the tantalum lamp—*i. e.*, the time within which it loses twenty per cent of its initial illuminating power—averages between 400 and 600 hours at 1.5 watts per Hefner candle-power. Some specimens have proved to have a useful life of as much as 1,200 hours. The absolute life, in general, amounts to 800 to 1,000 hours under normal working conditions. Further, we have to remark that the tantalum lamp blackens but little unless it has been strongly overheated during work in consequence of partial short-circuiting of the filament.

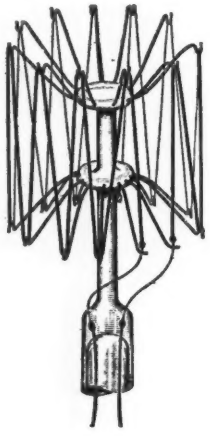


Fig. 7.

It is very interesting to observe the behavior of the tantalum lamp during the whole course of its life. The first fact worthy of note is that, like some carbon lamps, the illuminating value increases at the beginning, generally after a few hours, by fifteen to twenty per cent. In the same way the consumption of current rises by about three to six per cent, while the consumption of energy drops to 1.3 to 1.4 watts per candle-power. After that, the illuminating value gradually decreases, while a corresponding increase of the consumption of energy occurs. The average behavior of the twenty-five-candle-power lamp at 110 volts with reference to its various periods of life is shown in the following table:

Life in Hours.	Intensity of Light in Hefner C-P.	Consumption of Current in Amperes.	Watts per Hefner C-P.
0	25–27	0.36–0.38	1.5–1.7
5	28–31	0.37–0.39	1.3–1.5
150	25–27	0.36–0.38	1.5–1.6
300	22–24	0.36–0.38	1.6–1.7
500	20–22	0.36–0.38	1.9–2.0
1,000	18–20	0.35–0.37	2.1–2.2

The initial increase of illuminating value and current consumed is doubtless caused by a change in the structure of the tantalum wire, this change being accompanied by a reduction of resistance and, consequently, of the phenomena resulting therefrom. We may say at once that after a certain amount of use the filament presents a radical change in appearance when viewed with the naked eye. While the fresh filament has a perfectly smooth and cylindrical surface, it acquires a peculiarly glistening aspect as it grows old, so that a lamp having served for some time can be readily distinguished from a new lamp. When looked at under the microscope, the filament that has burned for a length of time shows a clear tendency toward contraction and formation of drops or beads. Fig. 5 is an illustration of a piece of filament in its fresh state and of the same piece after 1,000 hours of service, the specimen in each case being magnified 100 times. This gradual shortening of the filament can also be observed in the lamps themselves, and offers a further indication of the age of a lamp.

Fig. 6 represents the filament frame of a new lamp. It will be noticed that the tantalum wire is led up and down and hangs loose on the supporting frame in easy wide arches, without sharp bends. But after being used for some time the aspect of the lamp is quite different. As shown in Fig. 7, the wire has contracted, the wide arches have disappeared and sharp-pointed angles have taken their place.

The behavior of these lamps is most peculiar when the filament has burned through. While with all other incandescent lamps the burning through of the filament is tantamount to the economical death of the lamp, it may happen with tantalum lamps that they burn through several times without being rendered useless; on the contrary, each burning through is followed by an increase, often considerable, of the illuminating power. This peculiar result is due to the fact that in many cases a broken wire comes in contact with its neighbor, so that the circuit is again established. A part of the filament is thus cut out of the circuit, and the lamp consequently burns more intensely, and sometimes even too intensely, in which case, of course, only a short span of life is left to it. Yet we have had more than one lamp under observation, the filament of which broke for a first time after a short period of service and then broke repeatedly, but notwithstanding this the lamp lived more than 1,000 hours. We have often succeeded in rendering a lamp with a broken filament serviceable again by tapping it to bring the broken piece into contact with its neighbor. Fig. 8 represents the frame of a lamp in which the filament was burned through in three places, and yet continued to do service. For the sake of clearness, the back spans of the filament have been omitted in the drawing, while the front spans which were carrying the current are drawn in specially heavy lines.

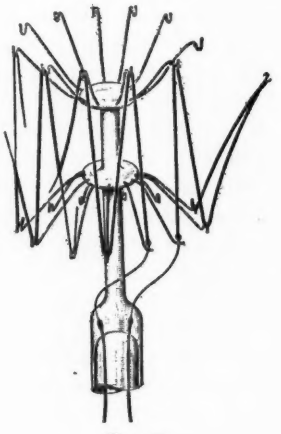


Fig. 8.

It must further be mentioned that after serving for some time, say 200 to 300 hours, the tantalum filament loses a great deal of its mechanical resistance; while, as has been stated by Dr. von Bolton, tantalum wire, when new, has a greater tensile strength than steel; it becomes brittle, and will break easily in the course

of its life as a filament. It is therefore advisable when lamps have served for some time not to remove them from their old fittings and put them into new ones, as that might easily cause the filament to break. New lamps are not very sensitive to strong shocks, even while burning, but when this alteration in the filament has occurred it is well to preserve them from shocks.

The behavior of the tantalum lamp under a very great increase of voltage is of special interest to the incandescent lamp maker. As was to be expected, the trials made in this respect have also shown the superiority of this lamp over the carbon lamp. It has been ascertained that tantalum lamps for 110 volts, twenty-five Hefner candle-power and 1.5 watts per candle-power only burn through at 260 to 300 volts if the pressure is increased slowly and gradually, while with carbon lamps designed to work under the same conditions nothing like that figure can be obtained. The superiority of the tantalum lamp over the carbon lamp with regard to blackening of the glass globe can also be proved in a few hours by means of comparative burning tests at about thirty per cent overload.

Another advantage of the tantalum lamp over the carbon lamp is that the resistance of tantalum, like that of all other metals, strongly increases with the rise of temperature, while carbon is known to diminish in resistance when it is hot. In Fig. 9 the variation of the resistance of tantalum and of carbon as a function of the voltage is graphically represented, the pressure being assumed as 100 volts and the resistance at 100 arbitrary units when the efficiency is 1.5 watts per Hefner candle-power, so that for each per cent of variation of voltage the respective percentage of variation of resistance is shown. It will be seen in the first instance that the resistance of the tantalum increases to more than five times its original value from the cold state to 1.5 watts per Hefner candle-power, while the resistance of the carbon decreases to about one-half of its initial value. It will further be noticed that even afterward the resistance of tantalum goes on rising, while the resistance of carbon keeps dropping. Therefore the increase or decrease of pressure causes the strength of current, and with it the illuminating value, to rise or fall at a quicker rate in the carbon lamp than in the tantalum lamp, and, consequently, the latter is less sensitive to variations of pressure than the former.

Having thus related the whole history of the development of the tantalum lamp, and fully entered into a critical comparison between it and the carbon filament lamp, we need scarcely add that we do not intend, of course, to be satisfied with what we have already obtained. For the time being, however, and until a larger building has been erected for the production of tantalum, our firm has resolved to keep to the type for which there is an immediate practical demand. That is the lamp for 110 to 120 volts, which supplies twenty-five Hefner candle-power at 110 volts, or will have a higher or lower illuminating value if worked at correspondingly higher or lower voltages. In conclusion, I would recapitulate the properties which

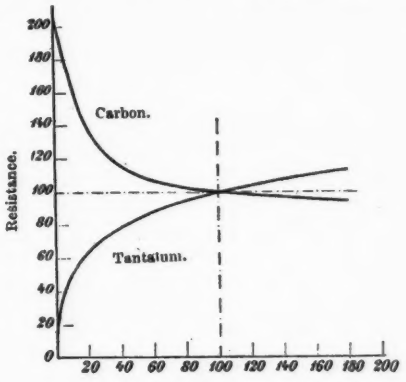


FIG. 9.

we claim as peculiar characteristics of our invention as follows:

1. The tantalum lamp has a filament made of a metallic conductor and burns at once on being connected without any previous heating.

2. The light-giving wire is prepared by melting in a vacuum and drawing; it is tough even in the cold state, and can therefore be coiled and fixed in the lamp when cold.

3. A relatively great length of wire can be placed in a simple manner within a bulb of ordinary dimensions.

4. Tantalum ore exists in considerable quantities and can be easily procured.

5. Similar principles of treatment can be adhibited to other metals of a very high melting point.

Application of Electricity to Steam Roads.[1]

The first essential requisite for the successful operation of a railroad by electricity is a continuous population requiring cheap, frequent and rapid transportation in the conduct and interchange of its daily vocations. This condition then calls for the operation of numerous small units and concentration of energy. Electricity can be used consistently for motive power on country lines when the source of supply is consolidated with an electric light plant or water-power company. Some small industrial roads are using electrical power from their manufacturing plants, but in such a case there must be a foundation to support the added cost of installation, for the electric railroad costs all that a steam line costs to perform the same service, and, in addition, the electrical installation in no case costs less than $3,000 per mile. The length of line which can be consistently equipped depends wholly upon the nature of its traffic and the density of population. Iowa will never be able to sustain numerous small electric railroads until the population in both cities and rural districts has greatly increased, and then not while the chief pursuit of the people is tilling the soil. Through the eastern states the cities are large and numerous and are made up of residents who are wage-earners in the large factories. The rural population is made up, to a great extent, of miners, gas and oil well drillers, and numerous other wage-earning pursuits. This is not true of Iowa cities. The population of Iowa cities is made up of a number of business men who have formed settlements or trading-posts throughout the state for the benefit of the Iowa farmer, who gets his income once a year when he markets his crop. He has a stable full of horses to haul himself and family to the trading-post once or twice a week; therefore the greater part of Iowa is destined to be without the rural or farmers' railroad for some time to come.

For yard work on the Waterloo, Cedar Falls & Northern road the electric locomotive is not feasible, neither is it suitable for drawing heavy freight and passenger trains, as the heavy trains would overload the power-house and no other cars would operate while they were being moved. One freight train would probably require the maximum output of the power-house, and we would be burning coal and conveying the power for miles over a conductor at a great loss in transmission, when we can burn the coal on a locomotive right at the point of service just as cheaply, considering the loss in conductivity. The amount of coal burned on our locomotives for the past eight months has been 1.4 tons per 10,000 ton-miles, while for electric service nine tons per 10,000 ton-miles have been used. This is not a fair comparison, for the reason that the coal used in the locomotives was the best screened Iowa and Illinois lump, while that burned at our power-house was the cheapest and dirtiest

[1] Abstract of a paper by Mr. S. Cass, president and general manager of the Waterloo, Cedar Falls & Northern Railroad, and read at the December meeting of the Iowa Railroad Club.

Iowa slack coal; and for the further reason that the principal part of this electric service was performed upon the city streets, where cars were stopped and started every few hundred feet, and no benefit was derived from momentum. The service engaged in by our switching locomotives comes somewhat nearer a comparison of the condition existing on most of the electric railroads. Our steam locomotives, when engaged in switching service, consume 0.3 ton of lump coal per hour, while our street cars require but 0.12 ton of slack coal per hour. The average weight of street cars is about one-third that of switching engines, so that it would be entirely fair to multiply the 0.12 ton per hour by three, making 0.36 ton per hour consumed by electric cars of steam switching engine tonnage. We should divide the 0.36 ton per hour by two, as the quality of coal used by the electric cars is not one-half as good and does not cost one-half as much as that used by the steam switching engine. We find then the result to be 0.18 ton per hour, or a saving of 0.12 ton per hour, by the concentration of energy in a central station, and, in addition, the saving of one man on the locomotive.

The cost of equipping a steam road with the necessary electrical conductors, power-house, substations, etc., of course depends upon the requirements of the line to be equipped. The minimum for small lines is $3,000 per mile. The motive power and electric coaches will cost as much as the same power and steam equipment; therefore the cost of this maintenance must be added to the present maintenance account, and the interest charged to the added cost of installation. Any one can now estimate whether trains operated by electricity will increase the revenue and decrease the operating expenses sufficiently to warrant the expenditure. All the labor saved on a train would be one fireman, and to offset this a high-salaried inspector must be kept in the locomotive house to look after the intricate electrical machinery under the cars. I do not see where any additional revenue would be derived from freight traffic, and the only way passenger traffic would be increased would be by stopping at cross-roads and entering upon the important streets of towns, as is done by purely passenger electric lines.

The present overhead system of electric railways is a menace to the safety of trainmen, whose duties require them to go on top of freight cars, and the third rail is prohibited in switch-yards on account of the danger to switchmen and other pedestrians. A short-circuit is another of the great objections to using electricity for motive power on trunk lines, for when it occurs the circuit-breaker opens at the power-house and cuts off the supply of current from each motor in the section of track affected. The greatest advantage in the application of electricity to steam roads, as applied with the present perfected electric apparatus, is summed up in four words—no smoke, no smell. There is no question but that there is a great field in which electricity can operate, and a great demand for electric transportation in the sections through which most of the trunk lines operate, but that demand should be met by providing the class of transportation which the local conditions require.

Electric Hoisting at a French Colliery.

An electric hoist of a novel type has been recently installed by the Compagnie des Mines Ligny-les-Aire, and is described in the London *Iron and Coal Trades Review*. The hoist is intended to raise 105 tons of coal per hour from a depth of 1,412 feet, at an average speed of twenty-four feet per second. Each cage has four decks, and the total load per cage is 4,800 pounds. When running at full speed about forty-eight trips an hour can be made. The hoist is mounted on a head frame directly over the shaft, at a height of sixty-nine feet above the ground.

The hoisting gear is of the Koepe type, and the main pulley is thirteen feet in diameter. In order to separate the two ends of the rope to a distance corresponding to the distance between the cage centres—three and one-half feet—a counter-pulley, also thirteen feet in diameter, is provided, and this is mounted on the lower stage of the head frame in the same vertical plane as the main pulley. The steel winding rope is one and one-eighth inches in diameter, and a balance tail rope is attached to the floor of the two cages. Each of the pulleys has two grooves—one for use in winding, the other serving as an auxiliary during the changing of the hoisting rope. The main Koepe pulley is mounted on two bearings, the shaft being coupled direct to two continuous-current motors with an aggregate maximum power of 500 horse-power. The motors are coupled direct to the two ends of the pulley shaft. In hoisting coal they run at a speed of thirty-eight revolutions per minute, producing a cage velocity of twenty-six feet per second. This speed is reduced to nineteen revolutions, or thirteen feet per second, when men are being raised or lowered, and to three-quarters of a revolution, or ten inches a second, during inspection of the shaft.

At starting, the maximum effort is about 600 horse-power, decreasing to 300 horse-power during the cage trip, and to nothing at the stops. To nullify the effect of these fluctuations at the primary station, a buffer set of motors has been installed, this set assisting at starting, governing the engine, and equalizing the load on the generating station, so that the latter is only called on to supply a constant force of about 300 horse-power, as though actuating a continuous motor. The buffer set consists of a starting dynamo, a buffer motor and supplementary motor, which are mounted on a common shaft carrying a large flywheel. When the hoisting motors are at rest, the starting dynamo—in series with the circuit—develops the same voltage as the primary station, but in the opposite direction, the consequence being that the voltage at the terminals of the winding motors is reduced to zero. At the moment of starting the cages, the excitation of the starting dynamo is lessened, so that the tension at the terminals of the winding motors is increased, and the latter begin to run, their speed increasing in proportion as the excitation of the starting dynamo diminishes. When this voltage has been reduced to zero the velocity of the rope attains to its normal value. From this point the excitation of the starting dynamo is reversed. Its voltage begins to supplement that of the circuit, and in this manner the total voltage is raised to 1,050-525 volts for each motor; whereupon the velocity of the hoisting rope attains a maximum.

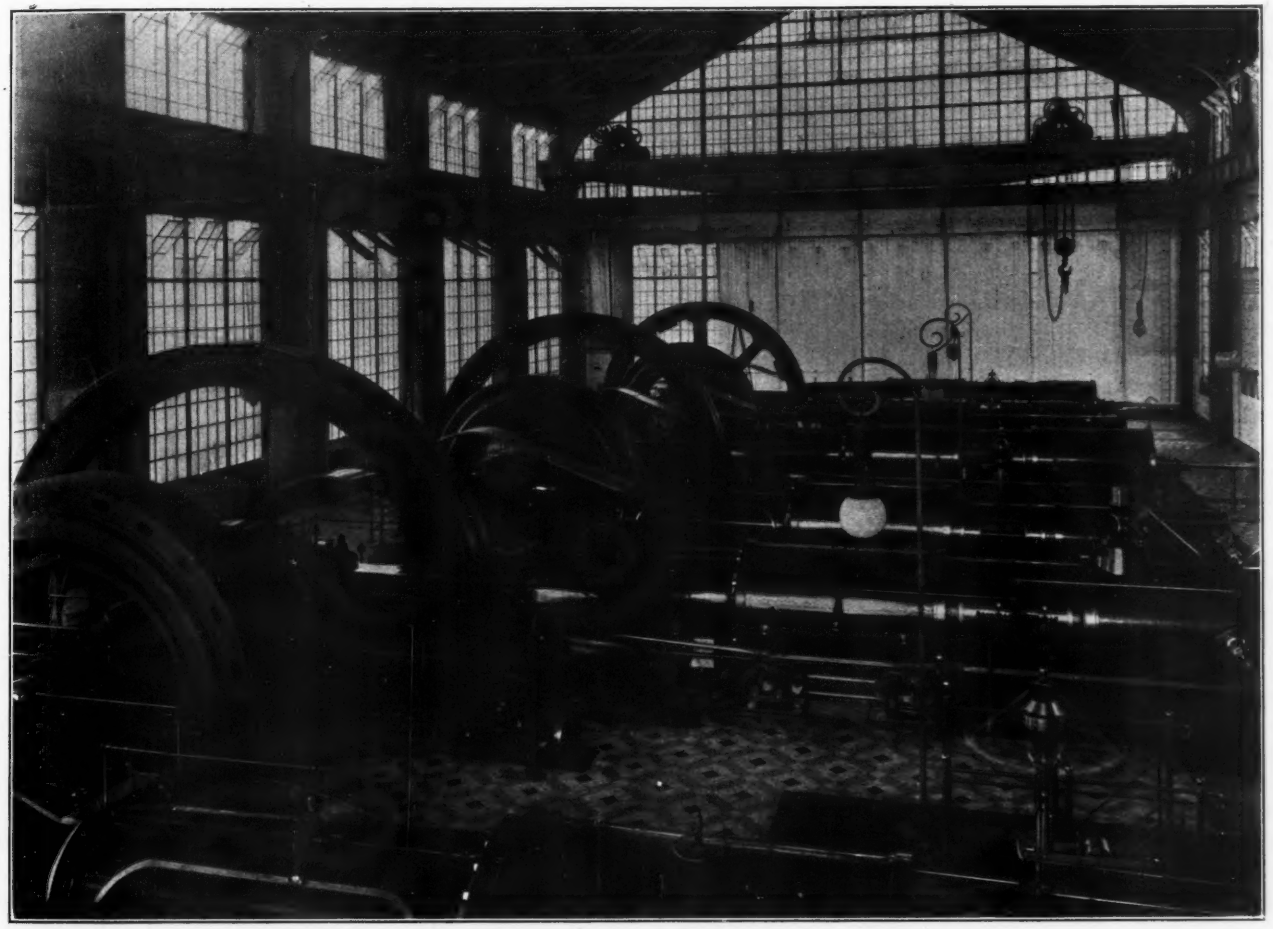
The governing is effected entirely in the excitation circuit of the starting dynamo. The regulator, with its resistances, takes the form of a controller, and is mounted on the lower stage of the head frame. It is actuated by a starting lever on the upper stage. The starting dynamo is actuated by a buffer motor coupled up with the primary station circuit in the ordinary manner. The supplementary motor is in series with the buffer motor, and is fitted with a regulator in its excitation circuit. When the voltage of this latter motor supplements the voltage of the main circuit, the tension at the terminals of the buffer motor increases, and consequently this motor runs at an increased speed. If the voltage of the supplementary motor is subtracted from that of the main circuit, the speed of the buffer motor is reduced. Intermediate speeds are obtained by setting the regulator accordingly, and by this means it is possible to vary the speed of the motor, and consequently of the buffer set, by thirty per cent.—*Engineering and Mining Journal.*

The New Paris Electric Railroad.

By C. L. Durand.

SOME years ago the Orleans Railroad Company, which operates one of the leading systems in France, decided to adopt electric traction upon a new branch of standard gauge double-track railroad which it opened up at Paris. This line was built in order to connect the Austerlitz terminal station which lies toward the eastern part of the city with a new station which should be more centrally located, so as to make it more convenient for persons having business in the central part of the city to reach the suburbs, and thus induce them to take up a residence in the districts which are traversed by the railroad. As will be remembered by a description which has been already given in a preceding issue, the electric branch runs along the Seine at the foot of the embankment or underneath the latter in tunnel. The line ends in the centre of the city at the extensive Orsay terminal station which was built a few years ago, lying entirely underground and containing a considerable number of tracks. The company found this a good occasion to test the operation of electric locomotives on standard gauge track, with a view of adopting it in the suburban part of the road should it prove all that was expected of it. The electric equipment was furnished by the Paris Thomson-Houston Company.

The first locomotives used were of a type which resembles the locomotive employed in America on the Baltimore & Ohio Railroad. As the operation of the line under these conditions gave the railroad company a favorable idea of electric traction, it decided to extend the system into the suburbs, and it has just finished the equipment of a standard gauge electric line alongside the other tracks. The new line runs as far as Juvisy, a distance of about twelve miles, in addition to the old portion between the Orsay terminus and Austerlitz or 2.5 miles, making a total of some fourteen miles. The company has added two tracks which are used exclusively for the electric line, thus keeping it separate from the other tracks. The use of the two tracks, allowing the suppression of crossings between the different tracks of the road, permitted them to reserve the two central tracks for the trains of the main lines using steam locomotives. The present arrangement thus gives a track on each side of the main line which is electrically equipped and is used for the suburban trains. Since the new electric branch started running, all the trains of the Orleans line which leave or arrive at Paris to the number of about 200 per day are drawn by electric locomotives over the portion along the Seine between the Austerlitz and the Orsay stations within the city. The suburban trains, which now number about seventy-five, still keep the electric locomotives between Austerlitz and the Juvisy suburban station, a distance of twelve miles, while the trains of



ENGINES AND ALTERNATORS, IVRY STATION, PARIS-ORLEANS ELECTRIC RAILROAD.

the main lines change over from electric to steam locomotives at Austerlitz before leaving the city.

The ensemble of the electric plant as it is now laid out for the Orleans line adheres to the same general dispositions which were adapted for the first part of the line along the Seine, namely, the production of three-phase current in the large station which was built some years ago at Ivry to the east of the city, using a number of substations along the line for changing to direct current at low voltage, by means of rotaries working in parallel with batteries of accumulators. The plant which was formerly installed for the road has been considerably modified and enlarged in capacity in order to provide for the extension of the road. The substation which was before located at Austerlitz has now been installed in the central station building at Ivry, while some changes have been made in the eight locomotives of the old type in order to adapt them for the new service. Two new substations form part of the increased plant, as well as eight new traction units comprising electric locomotives and motor-cars of a new type. The work upon the extension of the lines and enlargement of the plant was commenced in 1903 and it has now been entirely completed. This involved considerable difficulties especially as regards the construction of the tracks, as this had to be carried out without interrupting the traffic on the road.

As regards the generating and distributing part of the plant, the system which has been adopted by the Orleans company is laid out as follows: consisting in the first place of the main generating station at Ivry, where three direct-coupled units have been installed. These groups have a capacity of 1,000 kilowatts each on an average run, which can be raised to 1,500 kilowatts as a maximum. The station has an outfit of exciters, feed-pumps and different accessories. Besides the generating station, we find three groups of substations; first, a group of three substations for traction; second, a group of three substations for lighting the tracks and different buildings; third, a group of eight substations in which lighting is combined with transport of force by three-phase current.

As to the substations which are used for supplying current for the locomotives and motor-cars, the first is located at the Orsay station and comprises two rotary converters having a capacity of 250 kilowatts each, with a battery of accumulators of 290 cells, furnishing 650 kilowatts at a discharge régime of one hour. The second substation, which is located in the main station building at Ivry, is equipped with two rotary converters of 500 kilowatts each, also a third machine of 250 kilowatts and a battery of accumulators of 600 kilowatts capacity at the same régime as above. The third substation at Ablon is provided with two 500-kilowatt rotaries and one of 250 kilowatts, with a 900-kilowatt battery.

The direct current which is furnished by these substations, 600 volts on the average, is distributed on the one hand to the third rail of the track and on the other to the tracks which are used as the return circuit. The disposition of the third rail has been adapted in the present case to suit the conditions of the track, and thus between Orsay and Austerlitz, or along the old part of the line (2.4 miles), we find the third rail laid between the two tracks. Here the two conducting rails are laid side by side and close together. The return circuit is formed by the four rails of the main track which weighs thirty-eight kilogrammes per metre. On the portion of the road between the Austerlitz station and Juvisy, or 11.5 miles, the third rail which corresponds to each of the two outer or electric tracks is formed of a heavy rail of the Vignole type weighing fifty-four kilogrammes per metre. This rail is reenforced by two counter rails, each weighing twenty-eight kilogrammes per metre, thus making the total weight of the third rail 100 kilogrammes per metre for each track. In this case the return circuit is formed of eight lines of rail, taking in all four tracks, giving 8×38 kilogrammes per metre, as the rails of the two central tracks for the steam locomotives have now been connected in parallel with those of the side electric tracks.

The groups of three substations for lighting which has been previously mentioned uses a direct-current system of distribution at 500 volts, on the five-wire plan. Like the traction stations they receive three-phase current from the main plant at Ivry. In the latter case the substations employ direct-coupled motor-generator sets. The first substation, which is located at Ivry, is equipped with five groups of 100 kilowatts each. Each of the latter is formed of a three-phase synchronous motor working at 5,500 volts, coupled to a direct-current machine of 500 volts. Besides the above sets, there are three equalizing boosters of 20, 40 and 100 kilowatts capacity. The second, or Austerlitz substation, contains only two booster groups of forty kilowatts each, while the Orsay station has three 100-kilowatt direct-coupled sets, consisting of three-phase synchronous motors working at 5,500 volts and direct-current machines giving 500 volts. This plant has also three boosters of forty kilowatts each.

There are also eight substations which are used for lighting and transmission of power. They use three-phase current at twenty-five cycles. These plants include the following three substations: Chevalaret, Vitry and Choisy, which are connected on the line from the Ablon traction substation. Each of them has a normal capacity of thirty kilowatts and they are used for the lighting of the railroad stations and various buildings. The four substations of the Paris shops of the Orleans railroad each have a capacity of thirty kilowatts and are branched upon an underground high-tension cable coming from the main station. Last may be mentioned the substation of the locomotive depot of Paris which is also connected by cable with the Ivry plant. It delivers three-phase current at 220 volts for operating a number of light motors for the different operations of handling the locomotives.

The main generating plant at Ivry is illustrated in the different engravings. One of them shows a view of the boiler room. The coal is brought from the cars into the station yard and is unloaded by hand into a large bunker having a capacity of fifteen cubic yards and after sorting is taken by an inclined chain conveyer to a horizontal conveyer which distributes the coal to the boiler-feeding apparatus, which will be noticed in the engraving. The boiler outfit consists of eight boilers having 186 square metres heating surface, with a superheater of twenty-six square metres surface, and four boilers of 210 square metres surface, also provided with superheaters. The boilers are disposed so as to give about fifty degrees centigrade superheating. All of them are provided with automatic stoking and furnace appliances, with superheated steam-blast. The elevators, conveyers and stokers and grates are operated electrically and a special disposition allows of regulating the speeds of all the different parts. By properly adjusting these speeds, the coal feed and rate of combustion can be made proportional to the load on the machines of the station, and the personnel needed for operating the boiler plant is reduced to a minimum. The cinders which fall from the grates are taken off automatically by means of a horizontal conveyer and a vertical bucket conveyer and are loaded upon the cars. The water feed for the boilers is given by a set of pumps

which are worked from the main steam engines of the plant, and there are four other pumps which act as a reserve. The feed water is sent through two economizers, one of which contains 400 tubes and the other 448, and comes to the boiler at a temperature varying from 80 to 110 degrees centigrade. The station has two smokestacks 250 feet high and eight feet in diameter at the top which assure an excellent draught and are equipped so as to be worked with a steam blast, if need be. Regulating vanes are placed in the stacks and in the smoke conduits of the furnaces.

which are direct-coupled to vertical high-speed engines. Current can also be furnished by a synchronous motor group, consisting of a 5,500-volt three-phase motor, direct-coupled to a sixty-kilowatt generator.

The main switchboard for the high-potential circuits is illustrated here. It occupies a gallery over the main floor. The present switchboard differs considerably from the type which has been heretofore installed by the Thomson-Houston Company. As will be noticed, the front of the gallery contains the operating switchboard which has the form of a table, upon which are placed all the measuring and operating apparatus for the alternators and exciters. All the parts placed here have a voltage below 150 volts; the high-tension apparatus have been installed in the rear, and these are now operated from a distance.

In the middle of the gallery is the feeder switchboard, which is made up of standard panels of high-tension upon which are assembled all the protecting devices such as fuse plugs or circuit-breakers, also the measuring and working apparatus for the different feeders leaving the station. Lastly, in the rear of the gallery, is a series of twenty cement compartments which contain the main high-tension switches, the lowering transformers for the measuring instruments and all apparatus from which there might be danger.

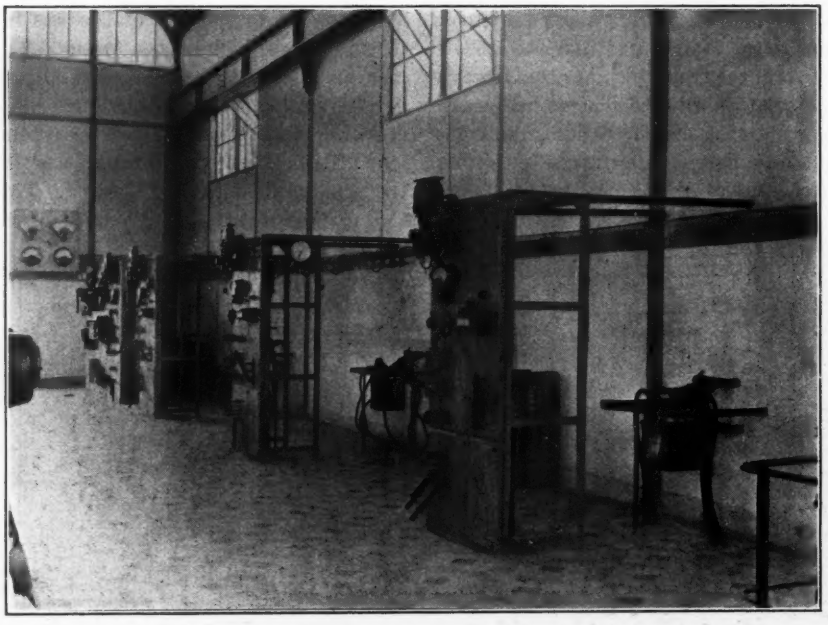
The machine and feeder circuits are all connected to two sets of bus-bars for the three-phase high-tension system. The bars are disposed so as to allow all the necessary combinations of circuits, and in case of need it is possible to divide the total load of the station into two parts, one for traction and the other for lighting. This arrangement simplifies the operation of the plant and makes it especially easy to run the alternators in parallel.

SWITCHBOARDS, IVRY STATION, PARIS-ORLEANS ELECTRIC RAILROAD.

The interior of the main dynamo room is shown in one of the views. It contains three direct-coupled units of 1,500 horse-power each. The engines are of the triple-expansion six-cylinder type. In two of the engines cylindrical valves are used and straight valves in the third. These engines make seventy-five revolutions per minute. On the main shaft is mounted a forty-pole alternator which has a capacity of 1,000 kilowatts and delivers 5,500 volts, three-phase current. The exciting current is produced by two small exciters of twenty and forty kilowatts capacity,

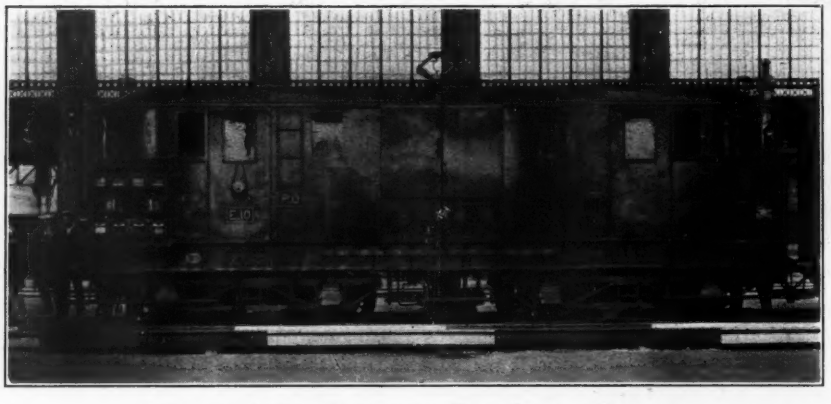
The system of high-tension lines has been well carried out. Four circuits leave the main switchboard. These lines are underground and carry 6,000 volts, three-phase current. The first three lines are used to supply the three traction substations, while the fourth circuit runs to the company's shops inside the city. The circuit from the main station to the Ivry substation is formed of two distinct cables, each of which carries three wires

of seventy-five square millimetres section. The line running to the second substation at Ablon, 7.2 miles distant, has two cables of three eighty square millimetres wires. These cables are specially insulated by a paper covering ten millimetres thick, which is provided for a working tension



SWITCHBOARD IN THE ABLON SUBSTATION.

of 11,000 volts. The fourteen miles of cable contained in these lines are divided into eight sections by the three transforming cabins at Vitry, Choisy and Chevalaret, where a system of high-tension switches allows of making all the necessary connections of the different

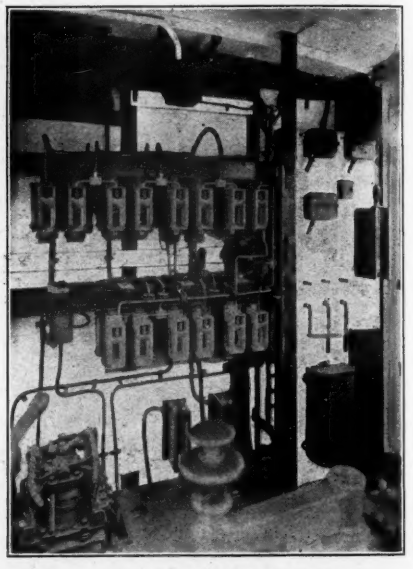


THE NEW ELECTRIC LOCOMOTIVE, PARIS-ORLEANS RAILROAD.

cable sections. This arrangement makes it easy to localize faults in case of accident and besides it has the advantage of reducing the inactive part of the cable to one-quarter of the total length of the line. After the underground line was laid a series of tests was carried out on the entire line, using 30,000 volts during one hour, in which case its performance was very satisfactory.

Two of the substations which receive the high-tension circuits and supply direct current for the traction lines are here illustrated. The disposition of these two plants as regards the capacity of the machines is practically the same. In each of them we find the following outfits: (1) one triphase rotary converter of 250 kilowatts capacity. (2) Two rotaries connected to furnish three-phase current, giving 500 kilowatts. Each three-phase outfit includes (*a*) one transformer for three-phase current, which is wound for a primary tension of 5,500 to 11,000 volts and a secondary of 440 volts; (*b*) a reactance coil for three-phase current, which is calculated so as to give a good distribution of load between the rotary converters and the storage battery, with a proper lag factor, the latter is 0.9 at the minimum; (*c*) a three-phase compound-wound rotary converter which receives 440 volts on the alternating-current side and delivers 625 volts, direct current. It has a capacity of 500 kilowatts on a continuous run. These rotaries carry a compound winding, and a switch which is placed upon the machine itself allows of connecting in shunt or in direct or inverse compound according to the requirements of running.

In each substation there are two motor-driven air fans which use three-phase synchronous motors of 375 volts and twenty-five cycles. These fans are used for cooling the transformers and reactances. The station contains a booster which is operated by belt from the main machines. It is employed for charging the storage battery and can furnish 800 volts for this purpose. The switchboards of the substations, two of which are illustrated in the figures, are of the standard Thomson-Houston type. The switchboard in the Ivry substation is provided with T-H oil switches and fuse plugs of the blow-out pattern. In the Ablon substation the switchboard carries oil switches of the FK type, with automatic throw. The panels of the direct-current lines are provided with the company's newly designed automatic switch for heavy currents, which can be regulated from 4,000 to 18,000-ampere loads, working at 600 volts.



IN THE CAB OF THE MOTOR-CAR.

The rolling stock which is now in use on the Orleans system includes the old locomotives which have been running on the Paris branch within the city, as well as a number of new ones which have been constructed especially for the new plant.

The latter have been running but a short time. There are eight of the old locomotives. Their construction has been described and illustrated in a preceding article. The new locomotive which the company has now adopted is shown in one of the engravings. Five motor-cars have also been built, and one of them is here represented. All the locomotives are equipped with four motors of the G-E 65 type, giving 270 horse-power. The motors are mounted two on each of the bogies. The ratio of gear reduction, which is 1 to 2.23 in all of the old locomotives except one, allows of making a speed of sixty miles an hour with the locomotive running alone, or a speed of forty-five miles an hour with a train of 200 tons on an average. Only one of the locomotives is provided with a speed reduction of 1 to 4.1. This is done in order to allow the locomotive to take a very heavy train at a slow speed, which is sometimes required.

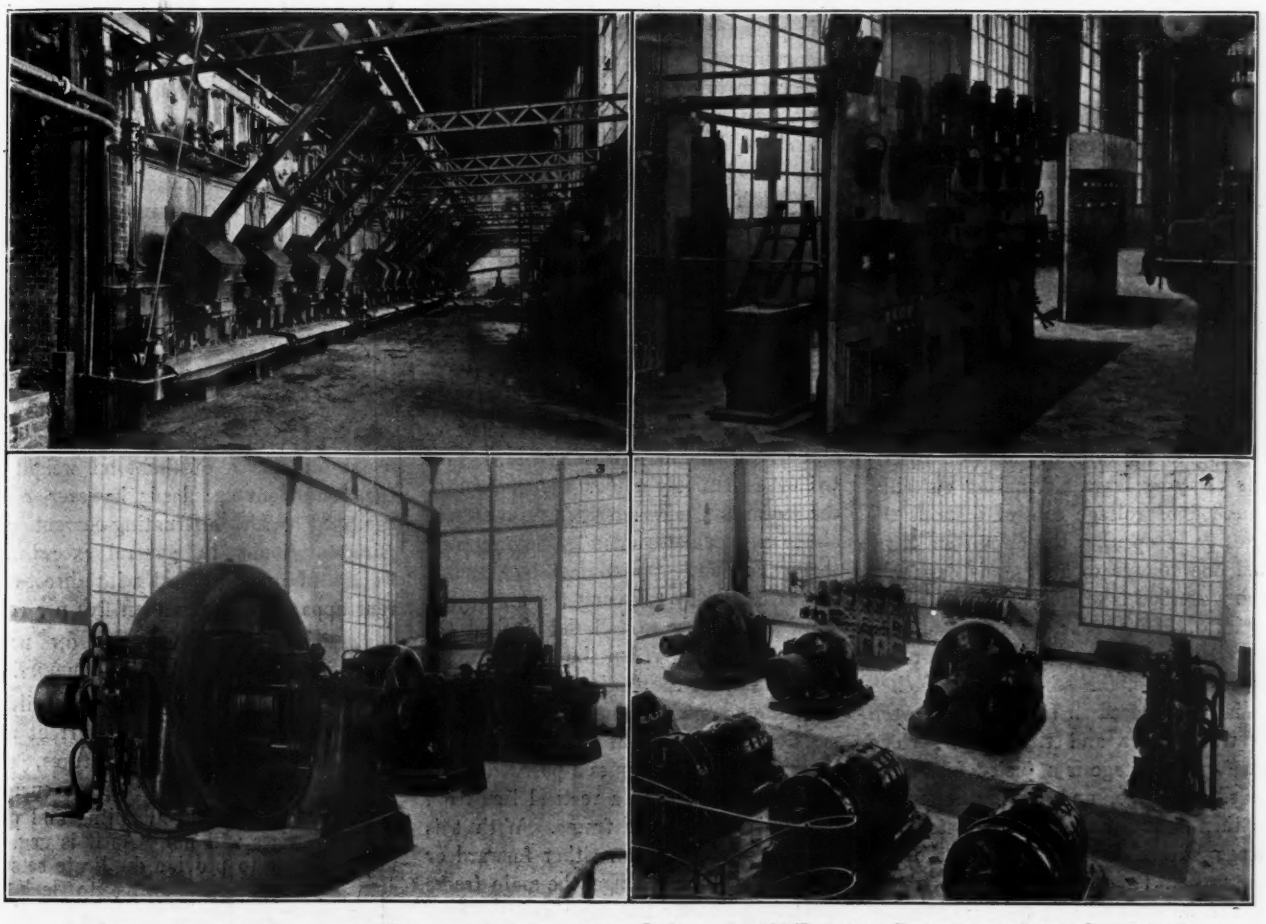
All the locomotives are provided with a special type of controller which permits of coupling the four motors, either in two groups of two motors in series or of two motors in parallel. The main controllers carry out the series parallel coupling of the two groups which are thus formed. As will be observed, the locomotive has a space in the middle which is reached by a double sliding door. Baggage or freight can be carried in this part. A door at the side gives access to the motorman's cab at each end. One feature to be noticed is the arrangement of the resistance coils and other apparatus at the side of the cabin. An exterior panel can be removed and so give ready access to the apparatus.

The principal figures for the new type of locomotive are as follows: weight when empty, fifty-five tons; length over buffers, 11.37 metres; length of car body, 10.2 metres; distance between axles of bogy, 2.39 metres; centre to centre of bogy, 5.64 metres; wheel diameter, 1.245 metres; gear ratio, 1 to 2.23.

The new motor-car is equipped with the well-known Thomson-Houston system of multiple unit control, with the addition of all the improvements in the apparatus which are the result of a long use of the system. There are four motors of the G-E 66 type per car. These motors are built for 125 horse-power. It is found that with two motor-cars per train, the total weight of 200 tons can be taken from Austerlitz to Juvisy in fifteen minutes, without stops. The train can be controlled from either one of the motorman's cabs. In each of these are placed the controllers, reversing switches, rheostats, etc., which form the equipment for controlling the train. A view in the cabin will be observed here, showing the disposition of the apparatus.

Special precautions have been taken in order to avoid fire. The cabins are entirely of metallic construction and fireproofed wood is used for building the car body. All the apparatus has been designed so as to make the operation as simple as possible with the greatest amount of automatic working. The main controllers contain many new features which render them superior to the former types. Special mention is to be made of a relay which is traversed by the current of the motors. It is used to block the controller by working a special brake, in order to prevent an accidental overload upon the motors.

The motor-cars have more than one-half the space for the passengers. The remainder of the space is taken up by a baggage compartment and by the motorman's cab at either end. The main dimensions, etc., of the motor-car are as follows: weight empty, fifty tons; length over buffers, 17.36 metres; length of car body, 16.2 metres; distance between axles of bogy, 1.98 metres; centre to centre of bogies, 12.4 metres; wheel diameter, 1.06 metres; gear reduction, 1 to 3.08.



1.—Boiler Plant at Ivry. 2.—Traction Switchboard at Ivry. 3.—500-Kilowatt Rotaries at Ablon Substation. 4.—Traction Plant at Ivry.

Car Equipment of the Single-Phase Railway System.

At the recent annual convention of the Northwestern Electrical Association, held in Milwaukee, January 18, 19 and 20, a paper entitled "The Single-Phase Railway System and Its Possibilities" was read by Mr. Clarence Renshaw. From this the following particulars of the Westinghouse car equipment are taken:

It is not in any advantage in the single-phase motor that the merit of the system lies, but to the use of alternating current. Many of the details of the car equipment are also worthy of notice as contributing their share to this same end.

In order to reduce the trolley voltage to a suitable value for use at the motors, a special form of air-cooled autotransformer has been developed. These transformers are arranged for mounting beneath the car and for being cooled by the breeze created by its motion. In some cases where railway lines are to pass through towns or cities in which a relatively low trolley voltage must be used, as well as through open country where a higher voltage may be used, the transformers are arranged so that the trolley circuit may be brought to either a high-voltage tap or a low-voltage tap by means of a double-throw switch.

Owing to the difficulty of opening circuits carrying large alternating currents, a method of voltage control without the necessity of opening the circuit in going from one voltage to another is desirable. Such a method is offered by the induction regulator. In the arrangement adopted for controlling the speed of single-phase railway motors, the secondary of such a regulator is placed in the circuit between the transformer and the motors. The transformer voltage is adjusted for an intermediate value, and by first opposing and then aiding it with the regulator, any voltage within the capacity of the apparatus can be secured. The regulator also can be stopped and held indefinitely in any given position, so that it is possible to secure a wide variation of running speed with any given condition of load or grade.

As the induction regulator may have a considerable torque, it is not turned by hand, but is rotated by a small pneumatic or electric motor and controlled by means of a master-switch.

The induction regulator, however, does not open or close the motor circuit but merely affords a means for controlling the voltage. A separate switch is therefore provided for this purpose. In order that the current handled by this switch may be as small as possible, it is placed in the primary circuit of the transformer instead of the motor circuit and the switching all done there.

For this service a special type of switch has been developed, which acts as a switch for the ordinary opening and closing of the circuit when power is turned on or off the motors and also opens automatically in case of an overload or short-circuit. The switch is closed by means of a plunger moved horizontally against a powerful spring, by the air pressure; when the air is released, the switch is forced open by the spring. As soon as the switch starts to open (and continuing until it is completely open), a jet of air at full reservoir pressure is blown between the jaws and ruptures the arc which is formed.

For the lower, such as 1,100, voltages the ordinary form of wheel trolley may be remodeled by the addition of extra insulation. For operating with trolley voltages, such as 3,000 volts or more, however, especially with multiple unit trains, it is desirable that some form of trolley be used which can be raised and lowered from inside the car and without the direct handling ordinarily required. To meet this condition, a form of bow trolley has been devised. The trolley consists of two parts, a main framework and a light contact bow hinged to it. This trolley is entirely under the control of the motorman. By admitting compressed air to a pneumatic cylinder he can raise the trolley until the contact bow strikes the wire, and by releasing the air he can allow the trolley to fall flat against the roof of the car. When the air is on, the main frame of the trolley assumes a certain angle with the top of the car, depending on the height of the wire; the contact bow then assumes a position about thirty degrees behind a vertical line from the top of the main frame. With this trolley the car can run either forward or backward with no change, the main frame remaining exactly the same and the contact bow adjusting itself in the proper direction without attention. The contact bow is very light so that it can readily follow any slight variations or irregularities in the wire.

Since the circuit of the main transformer is opened each time the car is stopped, the lights are operated from a similar auxiliary transformer similar in construction to the main transformer. The air-compressor outfit is driven by a small motor of the same type as the main motor, and this is also operated from the lighting transformer.

In equipments with induction control, the various auxiliary devices are operated by means of compressed air and controlled by electropneumatic valves. This arrangement, together with the pneumatic bow trolley, makes these equipments readily adaptable for use in trains with multiple control.

The above description refers in general to equipments aggregating 150 horsepower or more per car. For smaller capacities the method of using loops from the main transformer in connection with a controller located on the car platform is used. As such equipments might often be used on cars not having air-brakes, all of the controlling and protective devices for such equipments have been designed to operate without the use of compressed air.

WEIGHT.

In general, the weight of the single-phase alternating-current motors is approximately the same as that of direct-current motors of the same capacity. The regulator and transformer for a four-motor equipment together weigh approximately the same as a single motor. A complete equipment, including all apparatus, will weigh approximately fifteen per cent more than a direct-current equipment of the same capacity. Since the weight of an equipment usually forms only about one-fourth of the total weight of car, equipment and load; however, a car equipped with alternating-current apparatus should in general exceed the weight of one equipped with direct-current apparatus by less than five per cent.

EQUIPMENTS FOR OPERATION ON BOTH ALTERNATING AND DIRECT CURRENT.

The series alternating-current railway motor, being merely a direct-current motor with certain special features, will operate just as well with direct current at 250 volts, but the controlling and protecting devices will not. As it is usually impracticable to provide duplicate sets of auxiliary apparatus, owing to lack of space under the car in which to mount it, this means that if the car must operate on both alternating and direct current, a compromise must be made and the results on both alternating and direct current sacrificed somewhat in order to be able to operate with both. There are certain essential pieces of apparatus, such as the transformers, etc., which must be entirely cut out of circuit when direct current is used as well as various connections which must be entirely changed when alternating current is used. The switches for making these changes must be carefully interlocked so that all of the connections will be charged simultaneously. All of this add considerably to the cost and complication of the equipment.

The Indianapolis & Cincinnati Traction Company.

A Practical Application of the Single-Phase System to an Interurban Railway.

THE Indianapolis & Cincinnati Traction Company began regular service with a car equipped with single-phase motors in the city of Rushville, Ind., on December 30, 1904. It is significant that the parties principally concerned in this development have always been in the front rank of electric railway progress. To the Indianapolis & Cincinnati Traction Company and to President Charles L. Henry and his associates, and to Messrs. Sargent & Lundy, the consulting engineers, belongs the honor due the pioneer in this notable single-phase railway development.

The Indianapolis & Cincinnati Traction Company was organized on February 4, 1903, under the laws of Indiana, to construct an electric traction line from the city of Indianapolis, *via* Rushville and Connersville, Ind., to Hamilton, Ohio, and Cincinnati. The electric equipment of this system was furnished by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., and installed under the direction of Sargent & Lundy, of Chicago, consulting engineers. It is interesting to note the association of these names with that of Mr. Henry, when one realizes the prominent part the same interests have taken together in other important steps in the development of electric traction; the first interurban road in Indiana, between Anderson and Alexandria, having been built by Mr. Henry in 1897, the equipment furnished by the Westinghouse company, and the installation made under the direction of Sargent & Lundy as consulting engineers.

The affairs of the company are managed by a board of directors, constituted as follows: Charles L. Henry, Indianapolis, Ind., president and general manager; Ephraim Marsh, Greenfield, Ind., vice-president; William L. Taylor, Indianapolis, Ind., secretary; Endorus M. Johnson, Indianapolis, Ind., treasurer; James W. Fesler, Indianapolis, Ind.; Theodore F. Rose, Muncie, Ind.; William M. Frazee, Rushville, Ind.

The dominant idea in the minds of the originators of this company was to build a double track through line from Indianapolis to Cincinnati, which would take care of the traffic between these two cities in a more satisfactory way than is now done by the steam roads. To this end the company has secured a most desirable private right of way. Where the land is level and there are no considerable fills or cuts, a right of way four rods wide has been purchased, but wherever a considerable fill or cut has been necessary, additional width of right of way has been secured. In all the smaller towns a private right of way has been continued through, and the road is not constructed upon streets or highways except in cities or towns of such size as to make it necessary. In all cases inconvenient curves are avoided, and such an alignment has been secured between cities and towns as will permit of very rapid running, with entire safety to passengers and equipment.

In most instances the right of way is protected by a woven wire fence erected under an agreement with the landowner, whereby the landowner maintains the fence and keeps all its gates closed. Wherever such an agreement was not secured the right of way is fenced with barbed wire. In most cases the deeds of conveyance also provide that the company has a right to cut and keep cut any timber on adjacent lands that might interfere with wires or fencing, or with the operation of the railroad.

Under the provision of the franchises of the Indianapolis Traction and Terminal Company, interurban lines are allowed to enter the city over the tracks of the city company by such routes as the city designates, upon payment to the city company of an agreed or ascertained compensation. The Indianapolis Traction and Terminal Company has made a uniform agreement with interurban roads for entrance into the city over its tracks, whereby interurban roads pay four cents for each passenger carried on the interurban cars while on the city lines, and this entitles them to all of the privileges of the terminal station where all the interurban roads centre.

The Indianapolis & Cincinnati Traction Company has franchises in all of the cities and towns in Indiana through which the line passes, giving to it the most favored franchises within the state. They uniformly run for a period of fifty years, and contain no objectionable provisions regarding the pavement of streets, the erection of iron poles, or the payment of a certain franchise tax to the state or town. The franchises of the cities of Rushville and Connersville permit of running limited cars, making only one stop in each city. In all smaller towns limited cars are not required to stop. The franchises also provide for the carrying of freight, express and mail matter under reasonable regulations of the various cities and towns, so that the company confidently expects a large income from this source. All private rights of way and franchises outside of the cities and towns run in perpetuity.

Leaving the Traction Terminal Building at Market and Illinois streets in Indianapolis, the cars of this company will pass out over Ohio and Delaware streets, Virginia avenue and Prospect street to the city suburbs, and then east until they reach the C. H. & D. Railway. In going out of Indianapolis there are no grade crossings of railroads, all crossings being run overhead or under way. Thereafter, as far as the city of Rushville, the road runs parallel to and north of the C. H. & D. Railway; from the city of Rushville the line runs alongside and to the south of the C. H. & D. Railway to a point beyond Glenwood; from there on it follows almost an air line to Connersville, avoiding the bend of the C. H. & D. Railway and shortening the distance about one and one-half miles. From the city of Connorsville the exact route has not yet been determined, but it will be almost an air line to the town of Oxford, thereby shortening the distance; from there on it follows the C. H. & D. Railway as nearly as possible to the city of Hamilton. The company will build its own line from the city of Hamilton to Cincinnati, unless a satisfactory agreement can be made with the traction companies already running between these cities.

The line has already been constructed between Indianapolis and Rushville, a distance of forty miles, and a through service between these towns has been established. At an early date the road will be extended to Connersville.

ROADWAY.

The construction of the roadway is thoroughly first class and is equal to that of any line in the country. The track is graded in accordance with the best practice for steam roads; cuts and fills being made so as to avoid excessive or frequent grades. Between Indianapolis and a point eight miles east of Rushville—a distance of nearly fifty miles—there is no grade exceeding one and one-half per cent. From that point on toward Cincinnati the country is less level and in some cases

straight lines have been preferred, even at the expense of some increase in grade; but with the alignment and grade considered together, greater speed can be obtained with comfort and safety to passengers than on any steam road now running between Indianapolis and Cincinnati. So far as the profile of the road has been as yet determined, the heaviest grade will be four per cent, and it is believed that no greater grade will be necessary on the entire line.

The roadbed is graded twenty-eight feet wide on top for a double track, with slopes on fills and in cuts of one and one-half to one, and upon a grade line that puts the track in most instances above the level of adjacent lands, so as to avoid trouble on account of snow.

BRIDGES.

The bridges across all streams are constructed in the most approved manner, either with concrete arches or steel girders with stone abutments. The upper structures are built of the very best steel construction by the Indiana Bridge Company, of Muncie, Ind., of a capacity sufficient to carry a train of cars with a gross weight of one hundred tons for each car. All abutments are built for double track; the superstructures at this time are laid for one track only. It will be noted that provision is made for the increased demand for size of cars and length of trains likely to come in the near future.

TRACK.

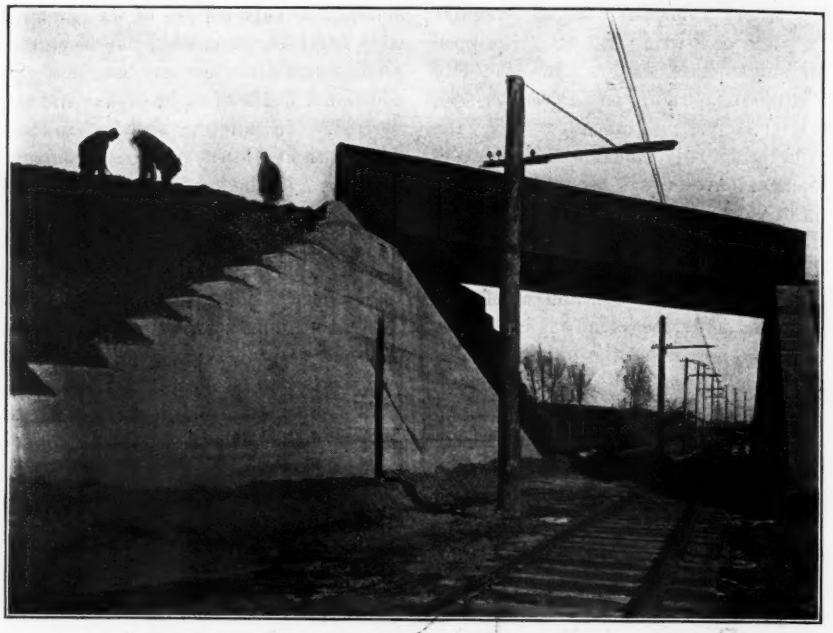
The road is laid with double track in the city of Rushville and on all highways; but on the private right of way, while the grade is prepared for double track, only one has been laid, as a second track can be more conveniently and economically put down later, when a sufficient portion of the road is in operation to require a double track. All ties used are first class (no culls or seconds); white oak, burr oak, and a few chestnuts, six inches by eight inches by eight feet long, 3,280 to the mile. The bridge ties are of long leaf yellow pine.

The track is laid with seventy-pound T-rail, in sixty feet lengths, connected with Weber rail joints, and bonded at the joints with No. 0000 ten-inch copper bonds, with seven-eighths-inch terminals under the plate so as not to be exposed. Cross bonds are put in every half mile and long bonds under all special work. The switches and other special work have been furnished by the Buda Foundry and Manufacturing Company, of Chicago, and are built according to steam railway standards. Turnouts and crossovers are constructed so as to avoid danger of open switches.

The company has secured a fine gravel pit, located within one-half mile of its main line at Morristown, Ind. The first layer of ballast has been put on the road from Rushville to Indianapolis, and the work will be completed as soon as the weather permits. The road is to be ballasted with gravel eight inches under the ties and level with the top of the rails. In the streets of Rushville, an eight-inch layer of broken stone was placed under the ties.

TROLLEY CONSTRUCTION.

The trolley wire is suspended along the private right of way from poles set in the centre of the grade one hundred feet apart, with a bracket made of angle iron looped at the end, so as to carry a large flat porcelain insulator, over the top of which is run a seven-sixteenth-inch steel strand cable or "messenger" wire. The No. 000 grooved copper trolley wire is carried eight inches under the messenger cable, to which it is attached every ten feet with specially made steel clamps, a construction known as the catenary sus-



OVERHEAD CROSSING OF C. H. & D. RAILWAY ON THE INDIANAPOLIS & CINCINNATI SINGLE-PHASE RAILWAY.

LAYING SIXTY-FOOT, SEVENTY-POUND T-RAIL, INDIANAPOLIS & CINCINNATI SINGLE-PHASE RAILWAY.

pension. The steel messenger wire is drawn tight. With this construction danger from trolley breaks is reduced to a minimum. The insulators are large and strong and are not likely to break, but if they should the steel cable would remain suspended from the top of the bracket. As the trolley is attached to the steel cable every ten feet, breaks will be very infrequent, and if one should occur not more than ten feet of the trolley would be loose. The catenary construction provides a practically level trolley with no sudden bends at the insulators as is found with the ordinary suspension, a point which is of great advantage to fast running cars. The trolley wire is suspended eighteen feet above the top of the rail.

Where the tracks are in the streets, the poles are set on the sides of the streets and the trolley is suspended from span wires. Otherwise the construction is the same as along the private right of way. The overhead material for the entire line construction was supplied by the Westinghouse Electric and Manufacturing Company, according to the design of Sargent & Lundy, consulting engineers.

Overhead Construction, Conductor, Indianapolis & Cincinnati Single-Phase Railway.

HIGH-VOLTAGE LINES.

The system of electrical distribution requires transformer stations about ten or twelve miles apart and the alternating current is transmitted from the power-house to these transformer stations at 33,000 volts, single-phase, twenty-five cycles per second, and is reduced and fed into the trolley at a potential of 3,300 volts. The high-tension current is carried from the central power station to the transformer stations on No. 4 bare copper wires, two wires to each transformer station. They make a complete circuit and permit the placing of the circuit-breakers and switches at the central power-house, so as to do away with the necessity of attendants at the transformer stations. The high-tension lines are carried on a separate line of poles set near the edge of the right of way, provided with carefully and strongly constructed cross-arms and equipped with large porcelain insulators on iron pins.

TELEPHONE LINES.

The entire system is provided with two metallic circuit (four copper wires) telephone lines, one of which is used exclusively by the train despatcher. The other line is used for general company business. Each car is provided with a telephone, by means of which the conductor can talk with the train despatcher at fixed points. Jack boxes are placed on the poles at intervals of 2,000 feet, from any of which the conductor of a car or any one else with a telephone can call up to report an accident or for any other purpose. The four telephone wires are carried by porcelain insulators on cross-arms near the top of the trolley poles, and are thus far removed from the high-tension lines. The wires are transposed every 500 feet in order to avoid disturbances from the current in the transmission lines.

POLES.

The poles are all of selected white cedar. Those for the centre trolley construction are forty feet long with seven-inch top. The side poles for the high-tension lines are thirty-five feet long, with seven-inch top. All are set six feet in the ground and are carefully tamped. Along streets on the side where there are no feed wires and the poles are used only to support the span wire, thirty-foot poles are used, while on the other side where the high-tension line runs, the poles are of varying height from forty feet to sixty feet, so as to carry the feed wires above the shade trees. All of the side poles along the streets are neatly shaved and painted and are set in concrete. The tall sixty-foot poles are of Idaho cedar, as smooth and straight as if turned in a lathe. The entire pole line was constructed under the direction of A. A. Anderson, general superintendent of the Indianapolis & Cincinnati Traction Company, and under the

Transformer Station, Indianapolis & Cincinnati Single-Phase Railway.

Boiler Plant in Power Station of Indianapolis & Cincinnati Single-Phase Railway.

immediate supervision of Oscar D. Emery, foreman. The work is of such excellent character throughout as to attract the attention of even casual observers, and among experienced linemen it has excited highest praise for its substantial character and artistic appearance.

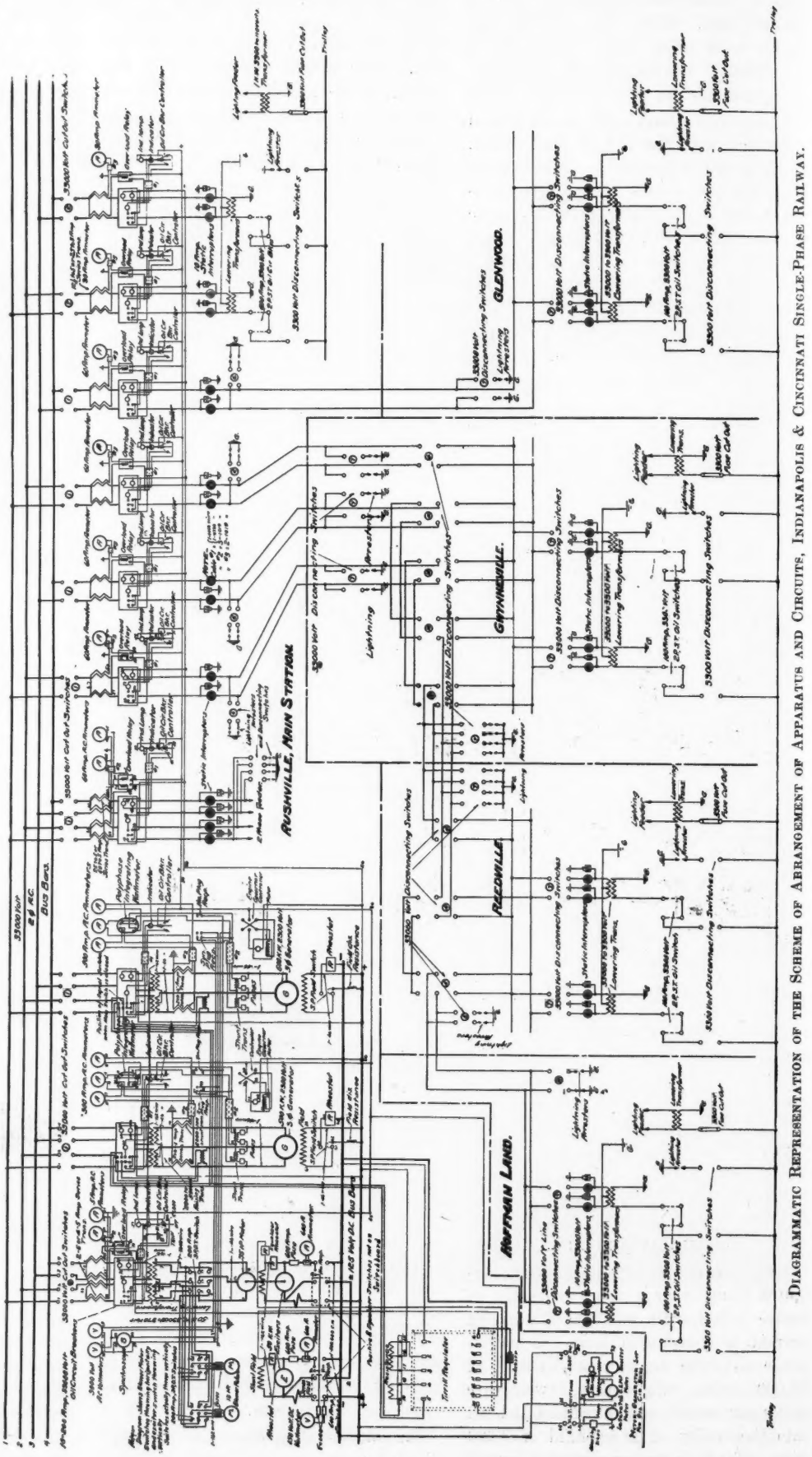
TROLLEY VOLTAGE.

Within the limits of the city of Indianapolis, a distance of approximately three miles, the cars will be run over already existing lines, and will be operated by direct current at 550 volts. Within the limits of the city of Rushville, they will be operated by alternating current at the same potential; on intervening sections the trolley will be fed by alternating current at 3,300 volts, twenty-five cycles per second, single-phase. Thus the first single-phase railway exemplifies the possibility of operating the same equipment from both direct and alternating-current lines and illustrates the voltage flexibility of the system, one of its most advantageous features.

The power station from which it is intended to operate the entire road is located at Rushville. From this plant 33,000-volt transmission circuits are run to the points of transformation and there reduced to 3,300 volts before connection to the trolley.

TRANSFORMER STATIONS.

As has been stated, the road is divided into sections of ten and twelve miles, each of which is supplied with current from a transformer station. Three such stations have been erected between Indianapolis and Rushville, by Pulse & Porter, contractors of Greensburg, Ind. The transformer houses are very small, measuring but twenty-one feet by twenty-three feet, but are carefully and substantially built. The foundations are of concrete; the walls are of brick laid in cement mortar; and the floors for both the first and second stories are of concrete upon



DIAGRAMMATIC REPRESENTATION OF THE SCHEME OF ARRANGEMENT OF APPARATUS AND CIRCUITS, INDIANAPOLIS & CINCINNATI SINGLE-PHASE RAILWAY.

steel beams. The roof is built upon concrete base. The doors and windows are provided with steel shutters, and the whole structure is made thoroughly fireproof and can be closed and left alone with safety.

In each of the transformer stations there are at present installed two 300-kilowatt, oil-insulated, step-down transformers, 33,000 to 3,300 volts. Space has been provided for an additional transformer of the same capacity. On the second floor of each transformer station there are installed the lightning arresters and disconnecting switches. There are no automatic switches of any type in these stations, as they are controlled only through the switchboard in the power station. There is nothing at the station which requires constant attention and only occasional inspection will be necessary. This does away with the expense usually incident with substations amounting to the wages of three men at each substation. The total annual saving on the ten transformer stations between Indianapolis and Cincinnati in wages alone is expected to be $21,900. In addition to this, there will be a large amount saved in the maintenance and repair of machinery.

The entire electrical equipment of the transformer stations was furnished by the Westinghouse Electric and Manufacturing Company, and was installed under the supervision of Sargent & Lundy. The disconnecting switches were made from a design specially prepared for this service by Sargent & Lundy.

The power-house serves as an additional transformer station, and contains two 300-kilowatt lowering transformers, wound for 3,300 volts primary and 550 volts secondary circuits, which are used to feed that portion of trolley included within the limits of the city of Rushville.

The accompanying diagram illustrates schematically the general arrangement of apparatus and circuits. The two-phase power circuit indicated is a provision for a four-wire power circuit, which it is proposed to run from the power-house in Rushville to the electric line between Indianapolis and Shelbyville, which is at present operated by direct current from its own power-house through rotary converter substations and direct-current railway motors. It is expected at an early date to operate this branch also from the central power station in Rushville.

POWER STATIONS.

The power-house, which is located at Rushville, Ind., is a strictly fireproof building of brick, concrete and steel, with rooms well lighted and skilfully arranged for future addition and enlargement. The site is adjacent to the C. H. & D. Railway with a connecting track from that road to the company's track alongside of the power station. The boiler room occupies one side of the building and is at present equipped with three 350-horse-power Babcock & Wilcox boilers. Natural gas is now being used for fuel, but provision is made for the burning of coal, if at any time the supply of gas becomes insufficient. The engine room occupies the other side of the building and is separated into two parts by a heavy brick partition. In the main room are installed the two generators, each of which consists of a 500-kilowatt Westinghouse revolving field alternator, twenty-five cycles per second, direct-connected to a 700-horse-power Corliss type, cross-compound, condensing engine, built by the Fulton Iron Works, of St. Louis, Mo. Both engines and generators are designed for an overload capacity of fifty per cent. Each engine is equipped with an independent jet condenser, made by the Dean Brothers Steam Pump Works, of Indianapolis, which take their water from an underground tunnel connecting to a large mill-race. Two pairs of 250-kilowatt air-blast transformers are arranged to change the current which comes from the generator at 2,300 volts, three-phase, to 33,000 volts, two-phase, for transmission to the transformer stations along the line. Air for these transformers is supplied by two motor-driven blowers. The generator field is excited by direct-current generators, one of which is direct-connected to an alternating-current, type C, Westinghouse induction motor; the other to a Westinghouse compound steam engine. The marble switchboard controlling-panels are also located in this main engine room, and the controlling apparatus is installed in the other portion of the building which is known as the high-tension chamber. The main bus-bars are located in the basement and are supported upon a masonry structure and separated by barriers of alberine stone.

The power-house was built according to plans and specifications of the consulting engineers, Sargent & Lundy, and all of the equipment was purchased under their specifications and installed under their supervision.

CAR SHOPS.

The car shops are located near the power station. The entire building is 205 feet by 104 feet, and is divided as follows: offices and waiting room for train crews, storerooms, blacksmith shop, car washroom, machine shop, truck repair shop, room for winding and drying armature and field coils and for other electrical work, paint shop and carpenter shop. Six tracks enter the building, each of which is provided with a working-pit. A transfer track runs across the centre of the building. The construction of the building is fireproof throughout, with concrete foundations and floors, brick walls and steel framing. The roofs are made of asphalt, gravel laid upon a cinder concrete base with louvers and skylights, all in steel frames. Concrete partitions are used where brick walls have not been constructed, and there is a Kinnear rolling iron door over every track. The machine shop is occupied with a full equipment of modern tools. Provision is made in the centre for a traveling crane to run the entire length of the building. The building was constructed by Angus Brothers & Company, of Chicago, Ill., and the steel structure was furnished by the Noelke Richards Iron Works, of Indianapolis, Ind., from the plans and under the specifications of Sargent & Lundy. The shop machinery was furnished by the E. A. Kinsey Company, of Cincinnati.

CARS.

The present equipment of the company consists of ten passenger cars, constructed by the St. Louis Car Company. Each car measures fifty-five feet over all, and is divided into three compartments. The first compartment is nine feet ten inches long and is intended to carry baggage. It is provided with doors opening on either side. The cars are intended for single-end operation and space for the motorman is provided in front of the baggage compartment, from which it is separated by a strong railing made of pipe. The middle compartment has a seating capacity for sixteen people and is intended for men desiring to smoke. The third compartment occupies the remaining portion of the car, and has a seating capacity for thirty-eight people.

The car is finely finished in mahogany, has plate glass in the windows and art glass in the ventilators and the upper part of the windows. The car body is mounted on Baldwin locomotive M. C. B. trucks with steel-tired wheels thirty-six inches in diameter, six-inch axle and five-inch by nine-inch journals. Each truck is equipped with two seventy-five-horse-power, single-phase, alternating-current, Westinghouse motors. Cars are equipped with the Westinghouse unit switch system of multiple control, and so may be

operated either singly or in trains. The motors are controlled by the rheostatic system and may be operated on either alternating or direct current. Both straight and automatic air-brakes are provided on each car, the straight being used when the cars are run singly, the automatic system when the cars are run in trains. The motors on the present car equipment are geared for a maximum speed of forty-five miles per hour for local service.

Each car is equipped with two trolleys; one of the Union Standard type with trolley wheel, to be used when operating from the direct-current lines in Indianapolis or from the low-voltage, alternating-current lines in Rushville; the second trolley is of the bow, high-speed type, and has been designed for service at 3,300 volts, alternating current.

It is confidently believed that with the high-voltage, alternating-current trolley wire and the sliding contact bow trolley adopted by this company that heavy freight can be hauled advantageously, without experiencing those difficulties heretofore encountered when service of this kind has been attempted on the direct-current system.

GENERAL OFFICES.

The general offices of the Indianapolis & Cincinnati Traction Company are located at Rushville. The office building is a three-story frame structure with slate roof; it is equipped with fireproof vaults, steam heat, electric light and a complete interior telephone system connected with the company's own lines and the commercial line. The building also contains waiting rooms and baggage rooms. The executive offices of the company are located in the Traction Terminal Building at Indianapolis.

OPERATION.

Local cars are operated each way every hour, making stops upon signals at all of the cities and towns and at the principal highway crossings in the country. These cars are all provided with compartments in which baggage and light express matter may be carried. They are designed to run at schedule speed of thirty miles per hour. To properly take care of the through service, additional "limited" cars will be put on the line; each of these will be equipped with four 150-horse-power motors designed to operate at a schedule speed of fifty or sixty miles per hour; as under the provisions of the various franchises they will not have to make any stops in the country or at any of the smaller towns and will only be required to make one stop at each of the larger intervening cities. It is expected that when the road is completed from Indianapolis to Cincinnati these "limited" cars will be able to make the trip from the centre of one city to the centre of the other in three hours' time.

It is the intention at a later date to run two express cars per day in each direction, taking care of the light freight and express business.

This road has been built in every detail with a view to the handling of heavy freight, even to the extent of carrying it in long trains. Whenever, in the intervening cities, short radius curves could not be otherwise avoided, the private property of the inside corner has been purchased and the sidewalks and curbs set back so as to make easy curves and permit the handling of heavy trains.

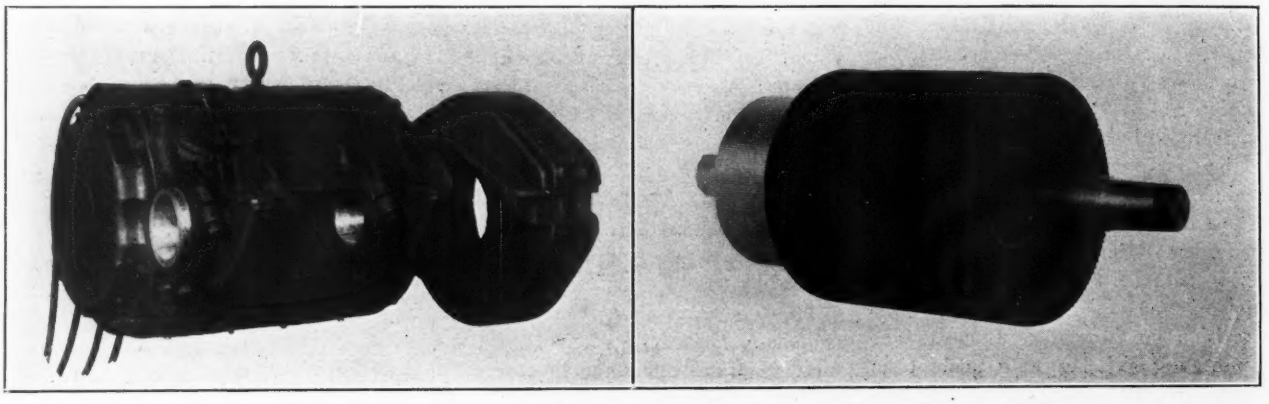
FARES.

An average fare of one and one-half cents per mile is charged by the company for carrying passengers, the road being divided into five-cent sections; no fare less than five cents is charged for any ride. A school children's ticket is issued, good for use one hour before or after school hours. A mileage or sectional ticket is also issued at a reduced rate, giving 160 five-cent rides for seven dollars, a reduction of twelve per cent from the ordinary fare. No other tickets are sold and cash fares are collected on the car.

The company now has its road completed from Indianapolis to Rushville and is arranging to extend the work as rapidly as possible, and expects the road completed at an early date. The road will be put in operation as far as Connorsville as early as possible in the present year.

The most interesting feature of the new installation is the absence of rotary transformer substations and the small amount of feeder copper used. In the trolley line, which is composed of No. 000 copper wire, no feeder circuit is necessary other than the No. 4 high-potential transmission line which carries the current from the power-house to the transforming points.

John W. Moore, chief engineer of the Indianapolis & Cincinnati Traction Company, has been particularly active in the construction of the roadway, bridges and track work. Mr. Arthur A. Anderson, general superintendent of the company, has carefully supervised the entire work of construction and operation. His past experience with the Indianapolis Street Railway and the Mahoning Valley Railway Company, of Youngstown, Ohio, has fitted him in a peculiar way for his present duties.



SEVENTY-FIVE-HORSE-POWER WESTINGHOUSE ALTERNATING-CURRENT SINGLE-PHASE, SERIES-WOUND RAILWAY MOTOR FOR ALTERNATING-CURRENT AND DIRECT-CURRENT CIRCUITS.

New York Electrical Contractors' Association.

The Electrical Contractors' Association, of New York, will hold a dinner at the Hotel Astor, Monday evening, February 27.

Incandescent Lamp Manufacturers' Meeting.

On Wednesday, February 8, a party of thirty or more manufacturers of incandescent lamps, members of the Association of Licensed Incandescent Lamp Manufacturers, left New York, *via* the Pennsylvania Railroad for Washington, where they were joined by a party from the West of about equal size. At Washington the entire party embarked on the steamer Washington for Fortress Monroe, where they arrived the following day, some hours late owing to large quantities of heavy ice in the Potomac river. Accommodations had been reserved for the entire number by Charles I. Hills, master of transportation for the association, and everything was done to make the three days' stay of the party a pleasant one, although the sessions of the meetings were carried through uninterruptedly, both morning and afternoon.

This meeting was devoted to the consideration of routine matters and was attended by nearly all of the companies operating under licenses granted by the General Electric Company for manufacturing incandescent lamps under its patents. One manufacturer said it embraced ninety-nine per cent of the entire production of lamps in the United States.

The last session was ended Saturday afternoon, in time for the members to catch the evening boat returning to Washington or to make train connections direct from Old Point Comfort.

Those present were E. E. Jackson, actuary, New York; Elmer W. Gillmer, Warren, Ohio; J. C. Fish, Shelby, Ohio; A. C. Garrison, St. Louis, Mo.; Charles Munder, Springfield, Mass.; C. J. Purdie, New York; J. Camp, Hartford; Charles I. Hills, New York; H. S. Ferguson, St. Louis; A. D. Page, Harrison, N. J.; J. B. Fay, Harrison, N. J.; H. H. Geary, Fostoria, Ohio; Joseph Insull, Pittsfield, Mass.; M. H. Nason, Cleveland, Ohio; H. B. Van Zwoll, Chicago, Ill.; E. H. Houghton, Chicago, Ill.; A. R. Hall, Denver, Col.; O. L. P. Sawyer, Cleveland, Ohio; E. T. Francke, Owensboro, Ky.; L. Lobenthal, New York; Col. E. E. Nash, Warren, Ohio; Frank A. Poor, Danvers, Mass.; D. E. W. Cushing, Boston; J. W. Holloway, Warren, Ohio; J. B. Estabrook, Ravenna, Ohio; Henry Hastings, Boston; Senator Willard Howland, Boston; George H. Smith, Boston; R. W. Morgan, New York; William Gilmore, Boston; A. H. Jackson, Harrison, N. J.; H. W. McCandless, New York; H. J. Jaeger, New York; Frank S. Terry, New York; J. Robert Crouse, Cleveland; N. L. Norris, Youngstown, Ohio; William Coale, Warren, Ohio; Glenn C. Webster, Warren, Ohio; W. D. Packard, Warren, Ohio; R. E. Pew, Warren, Ohio; J. C. Wormley, New York; Guy V. Ward, New York; A. H. Harriman, Middletown, Mass.; F. P. Wilcox, Harrison; E. Irving, Toronto; H. H. Albert, Niles, Ohio; G. F. Morrison, Harrison, N. J.; H. M. Van Zwoll, New York; H. E. Plass, New York; H. A. Tremaine, Cleveland.

Several other companies having allied interests were present. Among those were A. H. Patterson, New York; Fred Bissell, Toledo; S. O. Richardson and E. J. Marshall, Toledo; H. A. Hays, New York; F. H. Manchester, Providence; A. B. Haughton, Corning, N. Y.

Also a number of representatives of the several electrical journals, through the courtesy of the association, were with the party on this trip and at the hotel.

Among the several souvenirs of the occasion, the "License Label" brand of cigars provided by the commissary, Charles I. Hills, was so successful, inasmuch as the cigars were well worthy of being consumed, that it is the purpose to have it recognized as a standard brand hereafter.

Meeting of Telephone Men.

Representatives of twenty-seven telephone companies doing business in the Rochester district of the New York State Independent Telephone Association, including the counties of Monroe, Orleans, Livingston, Wayne, Ontario and Yates, met in Rochester, N. Y., on February 2. There are about thirty independent companies in the district. The following officers were elected: chairman, George R. Fuller, Rochester; vice-chairman, H. W. Blake, Naples; secretary, F. S. Bronson, Geneva. The next meeting will be held on May 4.

American Electrochemical Society.

The programme of the annual meeting of the American Electrochemical Society, to be held in Boston and Cambridge, Mass., April 25, 26 and 27, 1905, will include papers from Dr. Henry S. Carhart, Dr. Joseph W. Richards, Dr. W. D. Bancroft, Dr. A. A. Noyes, Professor Blake, Professor H. R. Carveth, Dr. Carl Hambuechen, Arvid A. Reuterdahl and C. G. Richardson. Interesting exhibits will be shown at the convention headquarters, and a number of excursions are being arranged. The hotel headquarters will be the Lenox, Boylston and Exeter streets, Boston, Mass.

Report of New York State Railroad Commissioners on Traffic Conditions in Greater New York.

The New York State Board of Railroad Commissioners has made public its report on the hearing recently given in Brooklyn, relative to the traffic conditions along the lines of the Brooklyn Rapid Transit Company. The commissioners announce their belief that permanent relief can best be obtained by building several tunnels connecting the boroughs. The great length of time, however, necessary to complete these has directed attention to a speedier method of relieving the conditions. It is proposed, therefore, to relieve the present congestion by connecting the Brooklyn and Williamsburg bridges by an elevated structure, with ample platforms for the prompt loading and unloading of passengers, the trains to be run continuously in both directions, at least doubling the present capacity of the approaches to New York trains. From this elevated structure a connection can be made with the Manhattan bridge, when completed; and the report further states that work on the Manhattan bridge should be accelerated.

The board recommends that the city erect loops and a shelter station on the Manhattan side of the Williamsburg bridge. The board also endorses the extension of Flatbush avenue, which will provide an additional artery through the business portion of Brooklyn to the Brooklyn bridge. Commissioner Best's plans for temporary relief at the Manhattan terminals of the Brooklyn and Williamsburg bridges are commended. This work will possibly be finished in July. The board urges that the work of lengthening the platforms of elevated stations, and the enlargement of terminal facilities at the East New York loop of the Brooklyn Rapid Transit Company, be hurried.

Regular Meeting of the American Institute of Electrical Engineers.

The 194th meeting of the American Institute of Electrical Engineers will be held in the chapter room, Carnegie Hall, 154 West Fifty-seventh street, New York city, Friday, February 24, 1905, at 8.15 P. M. The following paper will be presented and discussed: "Two-Motor versus Four-Motor Equipments"; by N. McD. Crawford, general manager of the Hartfort Street Railroad Company, Hartford, Ct.

Reviews of Current Engineering and Scientific Literature.

Progress in the Technology of Lighting.

In the concluding section of an article discussing recent progress in the art of illumination, Dr. W. Wedding, of Berlin, describes some interesting advances, and concludes with a comparison of the performance of different illuminants. He calls attention to the improvement in arc lamps which has made possible the burning of three lamps in series on a circuit, where, a few years ago, but two could be run. The third lamp now takes the place of the regulating resistance. A new lamp, referred to briefly, and which seems to Dr. Wedding to promise well, is the Tito Livio Carbone lamp. It employs two inclined, unimpregnated carbons, arranged as is the case in the flaming arc. By means of a magnet the arc is blown out into hemispherical form. It gives a white light with a green band around the equator. The lamp burns on a potential of ninety volts, and gives a quiet, steady light. The following table gives Dr. Wedding's comparison of the different types of illuminants now in general use: Under A are given the heat and carbon-dioxide given off by one person. In the use of this table it should be remembered that no general conclusions can be drawn. The lights most economical under certain conditions are entirely unsuitable for other purposes, but when everything is fully understood it serves as a valuable guide to the value of the different illuminants.—*Translated and abstracted from the Elektrotechnischer Anzeiger (Berlin), January* 26.

	Intensity of Light in Hefner Candles.		Hourly Consumption.	Hourly Development of Heat. Calories.	Calories per Candle. Per Hour.	Cost of Burning One Hour. Cents.		Hourly Production of Carbon Dioxide. Litres.	Energy Consumption for the Visible Rays per Candle. Watts.
	Horizontal.	Spherical.				Total.	Per Candle.		
Oil	14.8	13.2	43.6 grammes.	480.0	36.4	0.259	0.0197	70.1	0.113×10^{-6}
Gasoline	65.3	42.9	129.0 "	698.0	16 3	0.9	0.0209	119.0	0.0092×10^{-6}
Auer	73.8	52.3	112.3 "	573.0	11.0	0.33	0.0064	59.1	0.018×10^{-6}
High-pressure gas.	303.0	214.0	272.0 "	1387.0	6.48	0.92	0.0043	143.0	}
Lucas	581.0	411.0	630.0 "	3210.0	7.84	1.85	0.0045	332.0	} 0.057
Millenium	1500.0	1060.0	1200.0 "	6120.0	5.77	3.52	0.0033	631.0	}
Carbon filament, incandescent	43.8	34.6	104.0 watts.	89.8	2.4	0.99	0.0285	....	} 0.083
	18.3	12.8	59.1 "	51.0	3.99	0.56	0.0438	....	}
Osmium	42.3	31.4	48.7 "	42.1	1.34	0.46	0.0147	....	0.077
Nernst	184.5	113.0	213.0	184.0	1.63	2.03	0.0178	....	0.127
Arc	....	400.0	440.0	380.0	0.95	4.18	0.0105	10.7	} 0.021 to
Flaming arc	....	1800.0	440.0	380.0	0.2	4.18	0.0021	21.4	} 0.0047
A	....	....	....	75.0	....	....	....	14.0	....

A New Radioactive Product from Actinium.

An investigation was made recently by Mr. T. Godlewski, to determine whether a substance similar to uranium X and thorium X obtained from uranium and thorium is given off by actinium. Having in mind the similarity of actinium and thorium, both as regards their chemical and radioactive properties, it was determined to try the method of separation used by Rutherford and Soddy for obtaining thorium X. The experiments were at once successful for when ammonia was added to a solution of actinium in hydrochloric acid, the actinium was precipitated, while a small part of very active substance was left behind in the filtrate. This substance is similar in properties to the thorium emanation, and has been designated as actinium X. The product, AcX, immediately after separation was, weight for weight, a hundred times more active than the original actinium. The activity increased on the first day after removal about fifteen per cent of its orginal value, and then decayed with time. The curve of recovery of the actinium is complementary to the curve of decay of AcX. The behavior of the product is completely analagous in all respects to that of ThX, only the constant of change has a different value which is characteristic for AcX. The product, AcX, gives out both α, β and probably γ-rays. There is an interesting point of distinction between the radioactivity of thorium and actinium. After the separation of AcX, the actinium is almost completely inactive, only four per cent of the maximum activity being observed. Thorium and radium, on the other hand, always show a non-separable activity of about twenty-five per cent of the maximum. This points to the fact that the activity of ordinary actinium is due entirely to AcX and its successive products, and that little, if any, is supplied directly by actinium itself. The change from actinium to AcX is a "rayless" change.—*Abstracted from Nature (London), January* 26.

Variable-Speed Motors.

The advantages of shunt control of variable-speed motors are here urged by Mr. C. L. Sumpter. He points out the saving in cost and the greater simplicity of this system, as compared with the multi-voltage systems. Moreover, everything considered, the total cost of operation of the shunt motor is less. The application of these motors to the driving of machine tools is then considered, special reference being made to a five-horse-power motor having a range of from 300 to 900 revolutions per minute, which was directly attached to a vertical planer. On the cutting stroke this motor runs at its slow speed, and at the end of the stroke—the length of which is easily adjusted to suit the work—the motor reverses automatically. As soon as the reversal occurs, the resistance is automatically inserted in the field winding, quickly raising the speed to 900 revolutions for the return stroke. At the end of the quick return stroke, immediately before reversal, the field resistance is short-circuited, providing a strong field for reversing it, and the motor reverses and makes its slow-cutting stroke. The speed of reversal is dependent upon the peak of current which one cares to allow, a rush of current about two and one-half times the full-load current giving an instantaneous reversal, while, if required, the current can be kept practi-

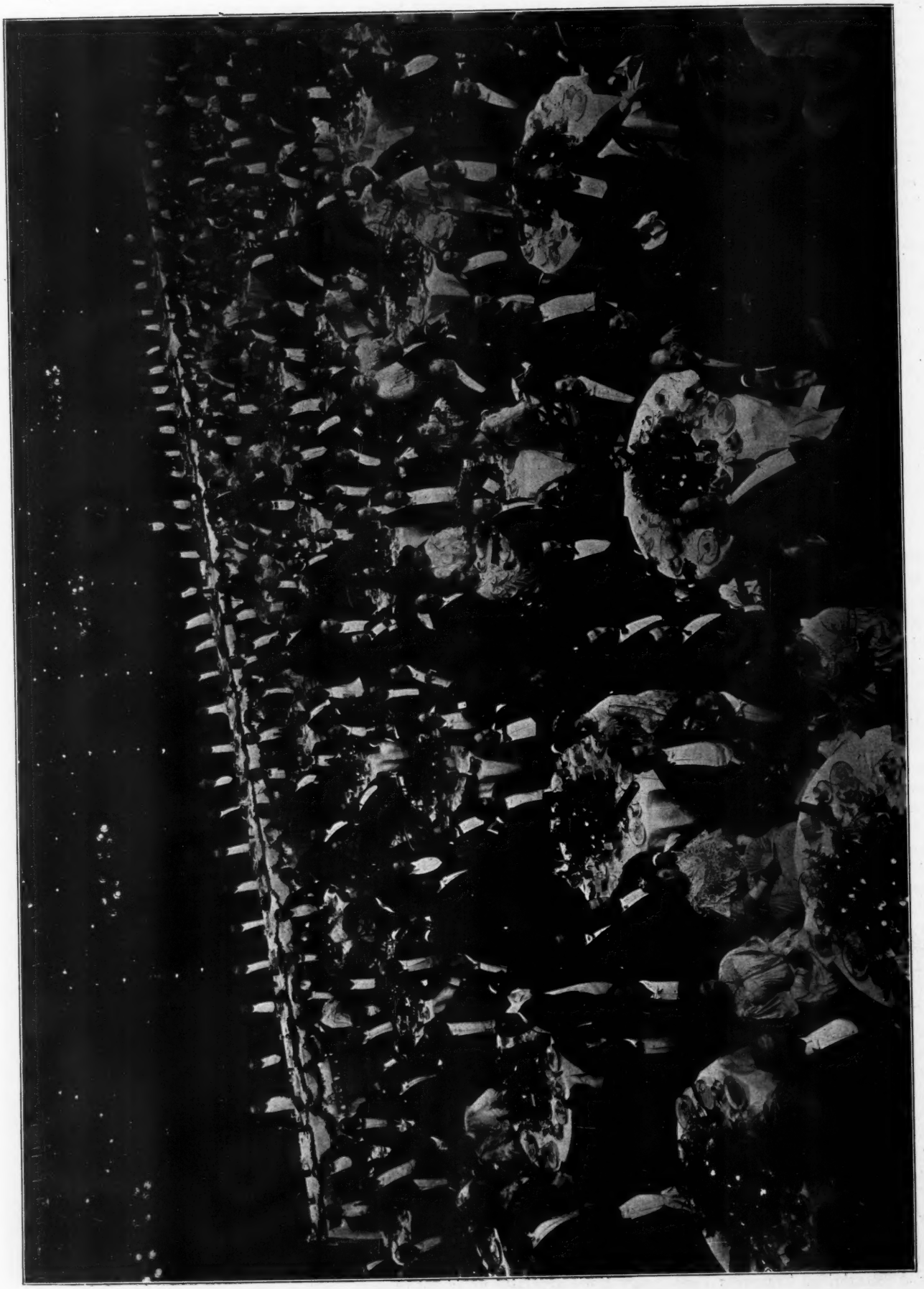
cally constant throughout by reducing the speed of reversal. Attention is drawn to the following advantages of this method. The energy in the moving parts is expended in bringing these parts to rest at each reversal. No additional power is required for this purpose. As the gearing may be eliminated and the moving parts reduced to the minimum, the efficiency approaches the maximum possible. There is no sparking at the commutator upon reversal. A smaller motor is sufficient owing to the absence of gearing and the reduced friction losses, because there is no shock upon reversal, and because the mean speed of the motor is high. The ordinary speed variation of the cutting stroke can be used to get the maximum speed of cut for different materials. The reversal of the machine is almost silent. These motors, at starting, develop the maximum torque, and have all the advantages in this respect of the series-wound motor.—*Abstracted from the Electrical Review (London), January 27.*

The Diesel Engine in Electricity Generating Stations.

An abstract is here given of a paper read recently by Mr. A. J. Lawson before the Glasgow Technical College Scientific Society. On the advice of the author, a Diesel engine was installed during the winter of 1902 to operate the tramways at Rothsay. During the last winter and at the commencement of the summer traffic it was constantly at work on the tramway service, except on such days in each week or fortnight as steam was got up in order to turn round the steam-engine sets, to keep them in good working order. Notwithstanding the fact that the oil fuel at Rothsay costs twenty-two dollars a ton, and the daily output of the station was only 370 kilowatt-hours, the cost per kilowatt-hour for fuel was about 0.68 cent. The engine is rated at seventy-five brake-horse-power, and is directly coupled to a fifty-kilowatt railway dynamo. Another similar engine was installed to supply the lighting for the carsheds for the Greenock and Port Glasgow tramways. This engine has been in operation since August, 1903, with a nightly output of sixty kilowatt-hours only—that is, with a fifty per cent load-factor. The total works cost for this set is given as 1.34 cents. The results of these two stations being so satisfactory, an engine of 160 brake-horse-power, directly coupled to a 100-kilowatt tramway generator, was installed by the Dudley & Stourbridge Tramways Company, to supply the outlying portion of the network. An official test of this engine gave a consumption of 0.664 pound of oil per kilowatt-hour. The friction load alone consumes 14.5 pounds of oil per hour. The mean consumption is then 0.32 pound of oil per indicated horse-power-hour on steady full load. The cost of the fuel is then 0.334 cent per kilowatt-hour. The City of Birmingham Tramways Company installed, early last year, two 160-horse-power Diesel engines, direct-coupled to 100-kilowatt generators. These sets operate in parallel on a very fluctuating railway load. Notwithstanding this, the engines govern perfectly, and use crude petroleum costing $12.50 a ton. The total works cost for these units is 1.57 cents per kilowatt-hour, which is made up as follows: for fuel, 0.44 cent; lubricating oil, 0.214 cent; engine-room stores, 0.22 cent; water, 0.06 cent; salaries and wages, 0.812 cent; repairs, 0.222 cent. If the load-factor had been twenty-five per cent, the total works cost per unit could have been reduced to 0.964 cent per kilowatt-hour. In the above figures the cost of cooling water is excessive, as the water, after passing through the jackets, was allowed to run to waste. It is now being saved and used over again.—*Abstracted from the Mechanical Engineer (London), January 28.*

Breaks in Overland Telegraphic Communication Due to Storms.

Some of the remedies proposed for preventing the interruption of telegraphic communication brought about by storms are here considered by Mr. William Maver, Jr. As early as 1849 the possibility of the collapse of telegraphic communication was brought to the attention of telegraph officials by a heavy sleet-storm which visited Tennessee, Kentucky, and other states in that vicinity, and since that time hardly a winter has passed during which the telegraph service has not been badly crippled in one section or another by sleet or snow-storms. Various remedies were proposed to avoid this, among them being the laying of underground cables. From an operating standpoint, however, an overland wire is from fifteen to twenty times more efficient than an underground or submarine cable of equal length. For example, an Atlantic cable operated with the apparatus employed in overland Morse telegraph would have a rate of transmission not exceeding two or three words per minute. On cables 400 to 500 miles in length the rate of transmission with ordinary Morse apparatus would not be more than six or eight words a minute. It is only by using the most sensitive receiving instruments that rates of twenty-five to thirty-five words per minute can be obtained in long-distance work; and if receiving apparatus of this high sensitiveness were employed on land lines it would entail using twisted and paired circuits to avoid the effects of mutual induction. It would also involve the equipping of the various offices with the necessary cable apparatus, and the keeping of a staff of expert operators. The agitation for underground telegraph lines has been carried on in Europe as well as in this country. In 1897 the British post-office department began laying an experimental underground line between London and Birmingham, a distance of 113 miles. The total cost of this was $800,000, or approximately $7,000 per mile. To give an idea of the cost of replacing existing overland wires in America with underground cables, it is stated that a conservative estimate of the expense of laying a fifty-conductor telegraph cable between New York and Philadelphia would be approximately $600,000, or $6,000 per mile. This would afford facilities for only twenty-five telegraph circuits, since two wires would be required for each circuit. At the present time there are perhaps 300 telegraph wires on the various pole lines from New York to Philadelphia, so that the suggested cable would carry but a small part of the business ordinarily transacted over overland circuits. Considering the territory traversed by the telegraph pole lines in America, the conclusion is almost inevitable that the placing of all these wires in cables underground is impracticable, owing to the enormous expenses and reduced efficiency of operation that such action would involve. The introduction of underground cables in cities lessens the efficiency of the automatic and quadruplex circuits, as well as of long-distance telephone circuits. The alternative to underground cables appears to be more substantial poles or wires, or to lay comparatively small underground cables between the principal cities of the country, over which the most important business might be transmitted during breaks in the overhead circuits. A lightly armored cable suspended on the pole line might preserve its continuity even when the poles are thrown down. Wireless telegraphy can not be considered as a remedy, for a severe storm would certainly blow down the vertical wires.—*Abstracted from Cassier's Magazine (New York), February.*



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THE ANNUAL BANQUET OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, WALDORF-ASTORIA, NEW YORK CITY, WEDNESDAY, FEBRUARY 8, 1905.
PHOTOGRAPH MADE WITH COOPER HEWITT MERCURY VAPOR LAMPS.

STREET RAILWAY HISTORY AND ORGANIZATION.

TWO RESPONSES MADE AT THE RECENT DINNER OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

At the recent dinner of the American Institute of Electrical Engineers, held at the Waldorf-Astoria, New York city, February 8, emphasis was given to the strides made in electric traction development. In the opening address President John W. Lieb, Jr., said in part:

The past year has witnessed the inauguration of some of the most important electric traction undertakings hitherto projected; we are enjoying the triumph of one of the most important and most successful works of public utility ever constructed and in which electricity plays so important a part —the rapid transit subway. During the year, also, work has been started on the electrical equipment of the great Manhattan terminals of the New York Central and Pennsylvania railroads; the electrification of important sections of the Long Island Railroad is fairly underway; successful tests have been made with single-phase electric railways; the Zossen-Marienfeld experiments have thrown new light on high-speed electric traction; and the powerful electric locomotives of the New York Central have shown their capacity for handling the heaviest traffic at high rates of speed.

The really "ancient history" of the art, as it were, goes back a little further, to the year 1835, when Thomas Davenport, a blacksmith of Brandon, Vt., constructed a crude electric motor with which he propelled a car on a circular track, deriving the current from primary batteries mounted on the car itself.

A few years later Robert Davidson made experiments on a somewhat larger scale in Scotland with a prototype of the modern electric locomotive, while Jacobi was propelling a boat on the Neva, in Russia, with batteries in each case as the source of power. Coming back again to our own country, Professor C. G. Page, of the Smithsonian Institution, under a subsidy from Congress, experimented with electric traction, and in 1851 made a trip from Washington to Bladensberg, five and one-quarter miles, with an electric locomotive equipped with Grove primary batteries and a sixteen-horse-power motor, attaining at times a speed of nineteen miles an hour. Professor Moses G. Farmer had previously made some successful experiments with an electromagnetic locomotive, and in 1851, assisted by Thomas Hall, he exhibited a car carrying passengers at the Mechanics Fair, at Boston, the current supply taken from stationary batteries through the rails.

Passing over the experimental work of Hall, Lilly and Dr. Colton in this country, the scene again shifts to Europe, where Pinkus and Swear in England, and Major Bessole in Italy, made such progress as was possible with the expensive and limited power that batteries could supply, but in many other respects anticipating experimentally the modern trolley, taking current from a wire alongside the rails or from an insulated third rail with return through the track.

About this time one of the indefatigable workers at the problem was C. F. Green, of Kalamazoo, Mich., who made some substantial improvements over previous workers, but could not overcome the difficulties inherent in the use of primary batteries as a source of current.

In 1879, Siemens and Halske, at the Berlin Industrial Exposition, operated an electric locomotive on a circular track about one-quarter of a mile long, a third rail supplying current to the car, which carried twenty passengers, at a speed of eight miles an hour, and this road was really the starting point of modern electric traction.

Just a brief mention of these early pioneers of whom our profession is so justly proud may be appropriate. The early experimental work of Stephen D. Field with electric motors in 1878 to 1879 did not find any practical application to traction until 1880, about the time that Thomas A. Edison built the historic road at his laboratory at Menlo Park, the rolling stock consisting of a locomotive, a freight car, an open car with benches, and the so-called "Pullman." The honor of inaugurating the first commercial electric road for regular passenger service belongs to Germany, the Lichterfeld-Berlin line having been opened to the public May 12, 1881. Then followed the Portrush line in Ireland in 1885, and some years later the Brighton, Blackpool and Bessbrook roads in England; and in 1883 and 1884 the Zauckerode, Mödling and Frankfort roads on the Continent, when a halt took place and further development there absolutely ceased until 1890.

In the United States, on the contrary, this was the beginning of feverish activity; 1883 and 1884, C. J. Van Depoele, Leo Daft and then Bentley, Knight, Henry and Rae made practical application of many of the fundamental principles and characteristic features of construction which are the basis of the modern trolley systems.

Brief mention should be made in passing of the experiments abroad, in London, Brussels and Paris, with cars equipped with storage batteries, with which the names of Julian, Reckenzaum and Elieson are associated, and in this country prior to 1887-1888, in New York, Washington and Baltimore, in which Condict, Mailloux, Reckenzaum and Bagnall took a prominent part.

It is, however, to another characteristically American inventor and pioneer to whom belongs the honor to have first demonstrated that the electric railway could be made to do something more than afford an interesting demonstration of the potency of electric power and the possibilities of electric transportation—a man to whose ability, courage and perseverance we owe the demonstration on a large scale of the practicability of electric traction. I refer, of course, to our honored past-president, Frank Julian Sprague. It required indeed a rare combination of these qualities which are characteristic of American engineers and American engineering methods—audacity, skill, perseverance and a strongly developed commercial sense —to have undertaken in 1887 the contract to electrify a complete railroad system of thirteen miles of track and twenty cars, and with the natural difficulties which the Richmond road presented.

Developments from 1887 to date in the application of electricity to traction purposes were so rapid that to attempt a chronological recital would carry me too far afield, and to merely mention the names of those who subsequently cooperated in this great work would be like counting the stars.

In responding to the toast, "The Broomstick Train," Mr. H. H. Vreeland, president of the New York City Railway Company, said, in part:

Trolley transportation system, from a managerial standpoint, in and about the great city of New York, is one of the most difficult problems that has ever confronted managers of the various properties which are operated in the territory in and about the city. They are called upon, speaking of transportation facilities as a whole, to move some 700 millions of people a year in Manhattan and the Bronx, and over 1,000 millions of people a year in the territory comprised within Greater New York. The problems connected with that are vast and of the greatest importance to the well-being and the orderly conduct of affairs of Greater New York.

Transportation facilities have always been the advance agent of civilization. Stage routes, post roads, canals and railroads have their place. The trolley car has rounded up the work by carrying the best type of latter-day influence to every farmhouse along its line. Man has become accustomed to working miracles. For the nickel the poor man has to-day what the dollars of the nabob could not have secured a century ago. We represent a class of corporations which is more intimately related than any other to the comfort, convenience and success of people who live in cities and towns. Upon the operation of street railways depends substantially everything else that goes on in thickly settled communities, and its value depends generally upon the sufficiency with which the public is served. They have studied and facilitated the public interests and needs, and have put themselves in advance of the development of the territories through which their lines run. At vast expense they have introduced new methods, new machinery, swifter, more frequent and improved accommodations.

The faithful discharge of their obligations requires a continually increasing investment; the constant incurring of new risks. It is not enough that they should meet demands as they exist from time to time, but they should anticipate them. The problem of to-day is not that of ten years ago. The men who ran the property at that time usually owned a large part of its capital stock and dictated its policy with their hands on their pocketbooks. To-day the policy is dictated by men who are technically and scientifically educated in the methods of management, control and operation of these large corporations. The character of the service which is rendered throughout the country, the development which is going forward to-day, now in the hands of men who have little or nothing to to do with the financial questions, is what has perfected the electric railway enterprises.

The interurban road has created a development both from the standpoint of the city and country which is not fully appreciated. We are all prone to look upon the one side with reference to what the interurban road does for the city dweller in scattering population and taking the city person to his suburban town. It is already developed to the extent that the farmers and the suburban dweller have been brought in contact with the activities of city life.

This is the day of association, when men band together for the achievement of every great work, and while one single mind may be the directing agency, in its execution the cooperation and support of a large number is essential to the accomplishment of any great enterprise. Instead of all the luxuries of life and the treasures of art and the gifts of genius being reserved for the gratification of the few, we find that the efforts of all men, whether emperors or kings with absolute and despotic power, or the representatives of a free people, either consciously or unconsciously, are directed to the diffusion of all the benefits which our high civilization produces and possesses among the masses of men.

In the purely material order, no factor has been more potent in the ennobling and uplifting of the masses of mankind than the development of the railway systems of the world and other means of rapid transportation, and no one agency employed in this development has been more effective than the science of electricity which is your special province, and in no one direction of its application are its results more wonderful than in the railroad world, in which I feel I have a right to take a deep and personal pride. For I may be permitted to say that my personal connection with railroad building and management has taken the widest range, commencing with the simplest tasks and ending with the management of a great system, which, while not covering a very great area of territory, vitally affects the comfort and well-being of the most important section and the most numerous traveling public in the civilized world, and all propelled by the electric energy driven along the simple trolley.

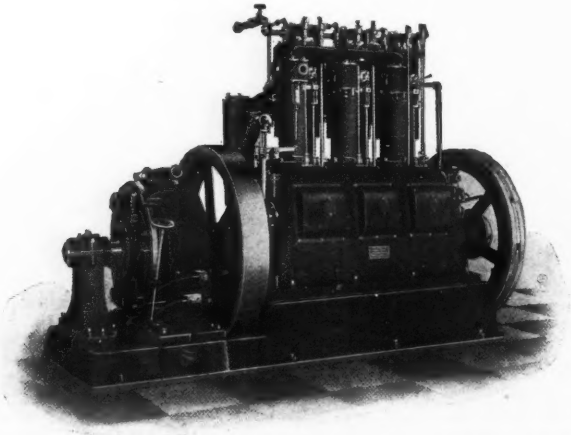
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Walrath Gas and Gasoline Engines.

The Marinette Gas Engine Company, Chicago Heights, Ill., is the manufacturer of the Walrath gas and gasoline engines. The accompanying illustrations show a seventy-five-horse-power, three-cylinder, direct-connected engine with generator on an extended shaft.

The Walrath engine is built in three styles—one, two and three-cylinder, all of the vertical type. The three different styles embody the same mechanical construction. The base is cast in one piece, is accurately bored to receive the cylinder, crank and cam-shaft bearings, and the bottom is planed level, ensuring perfect alignment of the engine when installed. The main bearings are separate castings from the base, and are all turned up together on an arbor to fit in a corresponding part of the circular bore made to receive them in the base. These bearings are removable without disturbing the crank shaft, and are adjustable for wear. They are lined with genuine babbitt, and in special cases are lined with phosphor-bronze.



THREE-CYLINDER VERTICAL GAS ENGINE, DIRECT-DRIVEN UNIT.

The cylinders are bolted to the top of the base, and fit into a bore made to receive them. This makes possible a perfect alignment and keeps them from getting out of true. Being of the vertical type, the cylinders are free to expand, without the objection of overhanging. They are cast of a special close-grain charcoal iron, and are water-jacketed to prevent overheating. In the multiple-cylinder types the cylinders are cast separate. This is a distinct advantage in this type of engine. If one cylinder is damaged beyond repair, it does not necessitate an entire new set of cylinders.

The cylinder head is fastened to the cylinder with studs of sufficient size and number to ensure a tight joint. The cages which contain the valves are placed within the cylinder head. The company claims a special advantage from this feature, as the valve may be taken out for regrinding or cleaning without disturbing the head or any of its connections; and in the multiple-cylinder type any one of the cylinders may be cut out while the engine is running, permitting a change of valves or igniter plugs without stopping the engine.

The valves are of the poppet type, and are two in number, one for inlet or explosive mixture, and the other for the exhaust. The valves have a positive lift and work vertically. On all sizes above and including ten-horse-power, single-cylinder style, and twenty-horse-power double-cylinder, both valves are placed in cages which fit into the cylinder head. The joint between the cages and head is ground so that to remove either valve is the work of a few minutes. This is done without breaking any water joints or gaskets.

The pistons are of the open-trunk type, and are made extremely long, giving a large surface and bringing the wear on the cylinder and piston to a minimum. The piston is kept tight by six snap rings of cast iron and requires no adjusting. The wrist pin is firmly held in position, and is of case-hardened steel.

The connecting rod of the engine is a steel forging of the eye and strap type. The best quality bronze boxes are fitted at both the crank and wrist pin ends. The boxes are made so as to be easily adjusted for wear. All of the rods are made three strokes in length.

The crank-shaft is made from a solid steel forging of the best quality of open-hearth steel of high tensile strength.

The flywheels are well proportioned to ensure good speed regulation, and in all large sizes have split hubs for convenience in putting them on the shaft and ensuring an accurate fit.

Balance weights are fastened directly to the crank-shaft on the single and double-cylinder type. By placing the balance weights on the crank they are brought as near as possible to the parts to be counterbalanced.

A starting device is supplied on all engines above twenty horse-power, and will be furnished with the smaller sizes if desired. The device is simple in construction and consists of an air-compressor and tank. The compressor is driven from any convenient point—generally from a small pulley placed directly on the engine crank-shaft. It is driven to charge the tank with air pressure from 150 to 200 pounds, depending upon the size of the engine. The pressure is kept stored in the tank until desired for starting. The starter valve is simply a type of piston valve which is operated by a cam and by means of ports making communication between the tank and engine cylinder. The air pressure is transmitted to the engine piston, which moves downward. The starter valve then opens communication between the engine cylinder and atmosphere, which causes the air to be exhausted from the cylinder after doing its work. The engine is caused to go through this series of operations until an explosion from the gases takes place. The air can then be shut off, and the engine will come up to speed with its own fuel.

These engines are adapted to run on natural, artificial, illuminating or producer gas, gasoline, distillate, kerosene or crude oil. The cost of fuel for operating a Walrath engine varies from 0.002 cent to 0.015 cent per horse-power per hour, according to the quality of fuel used and the price. It has been found in practice that approximately 11,000 to 12,500 British thermal units have to be supplied

per hour to produce one brake-horse-power-hour.

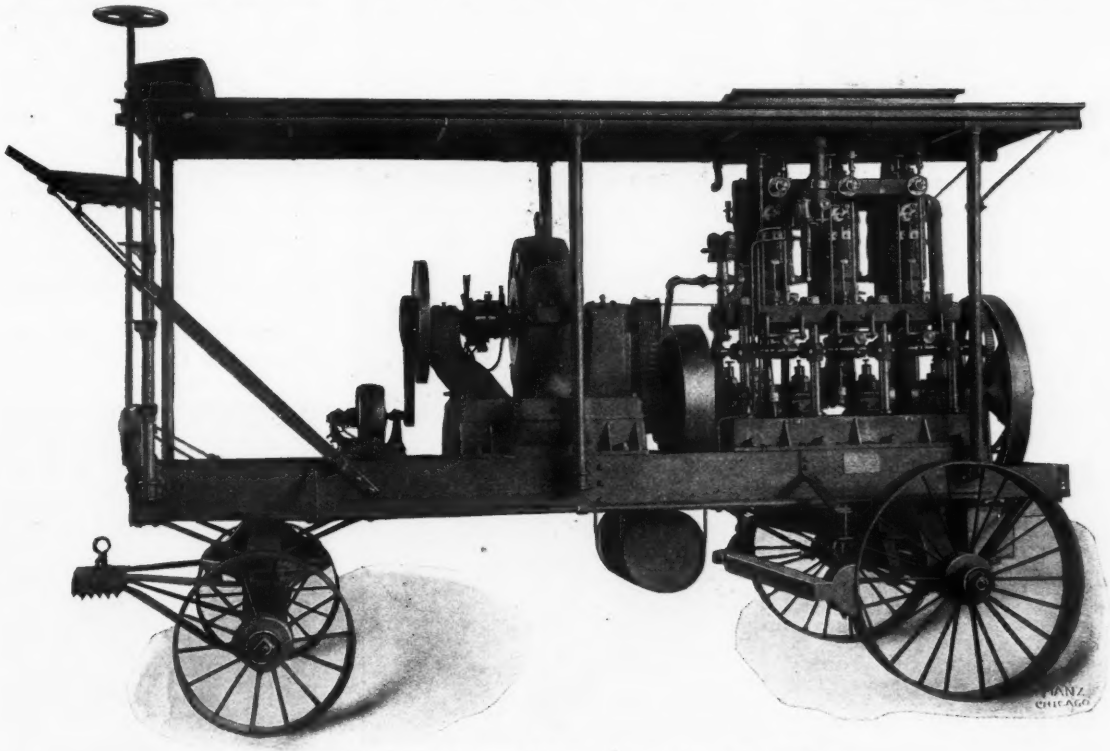
The igniter, which is of course a most vital feature of any internal-combustion engine, is considered by the manufacturer to be complete in every respect. It is compact in form and free from small parts which might break, work loose and cause trouble. The igniter is secured in place by two studs, and by the removal of the stud nuts is made easily accessible. The igniter can be removed without disturbing any other part of the engine, and on the multiple-cylinder type it may be removed and replaced without stopping the engine. This is because of the special construction, which permits of operating any one of the cylinders independent of the others. The igniter consists of a casting holding two electrodes, one of which is stationary and insulated from the main body of the casting. The other electrode is movable, and is operated by a cam which causes it to make and break contact with the insulated electrode. The contact points are of platinum wire, set in a small steel sleeve which may be removed without disturbing the electrodes in the plug if new points are required.

The well-known type of flyball governor is used. This is positive in action and is driven by means of bevel gears. It is made to operate a piston valve which regulates the exact amount of explosive mixture required for each impulse, and to maintain a steady speed under all conditions and variations of load. It controls the volume of mixture in proportion to the load it is carrying. This method of governing gives an impulse every second revolution for the one-cylinder type, and every revolution in the two-cylinder, and every two-thirds of a revolution in the three-cylinder type, irrespective of the load being driven.

The base of the engine forms a reservoir, into which the lubricating oil is placed, so that when the engine is in operation the connecting rod at its lower stroke dips into the oil. The rapid movement of the connecting rod splashes the oil over the working parts in the base, and also the inner surface of the cylinders. Besides this, oil cups are placed on the outside of the base, leading by means of pipes to all the main bearings.

These engines have been designed for general work—thrashing, pumping, sawing wood, or for ordinary power purposes, such as grain elevators, hoisting plants, railway pumping stations, irrigating plants, etc. For electric lighting or other service requiring especially close regulation of speed, the two and three-cylinder types of engine are recommended. For lighting plants of the belted type these gas engines are furnished in sizes from two horse-power to 300 horse-power, and direct-connected outfits in sizes from eight horse-power to 300 horse-power, including engines and generators.

One of the illustrations herewith shows a portable electric lighting outfit, two of which were made for a traveling circus company. These outfits have been in operation for the past two years with excellent results, lighting the circus tents entirely by electricity. The company states that during the first season the lights were out of service for but three or four hours, and during last season but a half-hour was lost by the lights being out of service. The engine is of the open-base type of design, to reduce the weight for portable service, and may be furnished for link belt drive, as is the case in this instance, or direct-connected to a direct-current generator.



PORTABLE GAS-ENGINE-DRIVEN ELECTRIC LIGHT AND POWER PLANT.

Westinghouse Sales Meeting.

The annual meeting of the traveling salesmen of the electric railway and lighting department of the Westinghouse Electric and Manufacturing Company drew about seventy-five representatives to Pittsburg during the week of January 30-February 4, one of the largest gatherings being at the dinner at the Hotel Schenley on Thursday evening. Mr. C. S. Cook, manager of the railway and lighting department, acted as chairman at the various meetings. The general sentiment of the convention was that there were busy days ahead in the electric railway field, the successful wide introduction of the electric motor into suburban traction service in the past few years having brought many of the great railroad companies to an appreciation of the great future of the electric railroad in interurban traffic. The meeting of the week, at Pittsburg, was particularly valuable in the opportunity afforded, not only for a close study of the latest shop developments in new motor types, but also for the discussion of the conditions and problems that have recently been encountered and solved in many important long-distance installations.

Electro-Lifting Magnets.

The Electric Controller and Supply Company, Cleveland, Ohio, builds electromagnets for use on cranes, etc. Some of the uses of these magnets are shown in the accompanying illustrations.

Wherever steel or iron is handled in quantities by means of cranes a magnet

ELECTROMAGNETIC LIFTING APPARATUS.

will effect economies in time and labor sufficient to pay for itself in from one to six months. This statement is borne out by experience in steel mills, jobbing houses, safe works, and is evident when the methods, chain versus magnet, are compared.

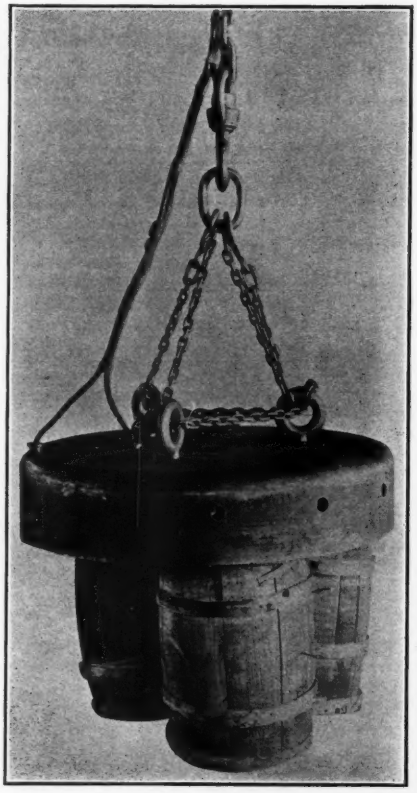
In all cases an electromagnet is used, suspended from the hook of the crane; direct current at any of the common voltages being employed to energize the magnet. A flexible twin conductor cable is used to convey the current to the magnet and a small switch operated by the crane man is usually the only additional apparatus necessary. The amount of current used is small, being from one to twelve amperes according to the service for which the magnet is designed.

In operation, the magnet is lowered upon the material to be lifted, and the switch closed, thus causing the magnet to attract and hold the material, which may then be hoisted by the crane and transported to the desired point. By simply opening the switch the material is instantly released.

Comparing this method of operation with the common methods of connecting the load to the hook of the crane with chains, hooks or clamps, the saving in both labor and time is apparent, as, in general, the attachment of the magnet to the load, as well as the release of the load, may be accomplished by the crane operator without assistance, thus saving the labor of one or more men for prying up the material, attaching hooks and chains at the point of loading and additional men at the point of delivery for unhooking the load from the crane.

Magnets can be so quickly attached to and detached from a load that by their use the work which may be done by a given crane is greatly increased, in some cases more than doubled. It frequently occurs that the attachment of lifting magnets to existing cranes so increases their capacity for handling material that the purchase of additional cranes for handling an increased output is rendered unnecessary.

Again, lifting magnets require much less headroom than hooks or chains for lifting material of considerable width,



ELECTROMAGNET LIFTING BARRELED MATERIAL.

such as plates. Therefore, by the use of magnets, material can be conveniently piled to a greater height in the storage space under a given crane than is possible when chains are used, thus increasing the capacity of a given storage space without altering the crane runway or increasing the size of the building.

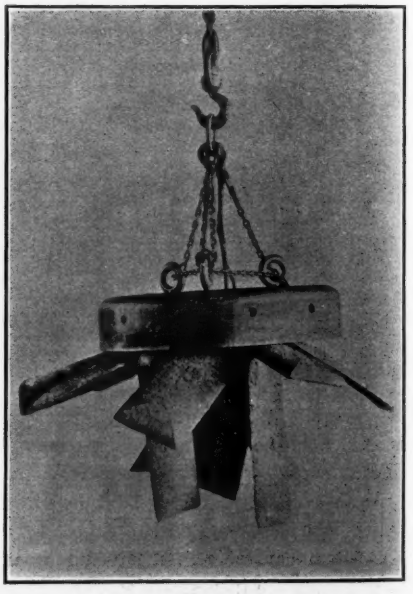
Lifting magnets may be used to great advantage in handling pig iron, scrap, rivets, bolts and similar articles in bulk, as shown in Figs. 1 and 2. Ingots, blooms, slabs, billets, bars, plates, rails, structural shapes, pipe, etc., may also be handled to advantage; Fig. 3 being an example.

The Illinois Steel Company uses fourteen magnets in its South Chicago works alone, and has found that economy in time and labor so substantial that it has decided to use them wherever possible in all its works.

A single design of magnet is not adapted to handling the full range of material above mentioned; on the contrary, the magnet must in every case be designed to meet the form of material to be handled. For instance, there is a wide difference in the design of a magnet for lifting ingots or blooms and one adapted to the handling of thin plates. A magnet which would handle five tons in the form of an ingot might not handle five hundred pounds in the form of thin plates. It is therefore necessary to understand in each case the operating conditions with special reference to the form and range of material to be handled.

The question of risk of accident rises. The Electric Controller and Supply Company, Cleveland, Ohio, reports that in its experience with scores of lifting magnets in successful operation it has yet to learn of a single accident which has occurred through their use; while, on the other hand, accidents due to the slipping and breaking of hooks and chains are known to be of very frequent occurrence.

Magnets are always built and tested to from four to five times the specified load,

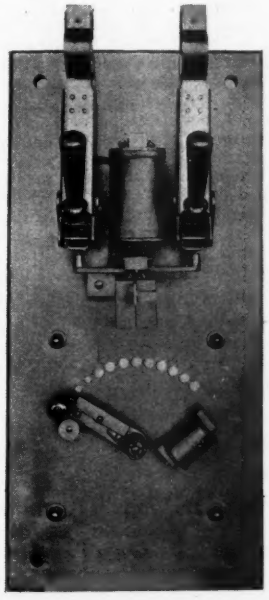


ELECTROMAGNET LIFTING BILLETS.

and in addition to its wide practical experience in the application of lifting magnets, the Electric Controller and Supply Company has at its disposal most complete and valuable data secured through the testing of some forty designs of magnets on a testing machine which it has constructed for this special purpose. Its designs are protected by the well-known Wellman, Clark and Peik patents.

Motor-Starting Panels with Circuit-Breakers.

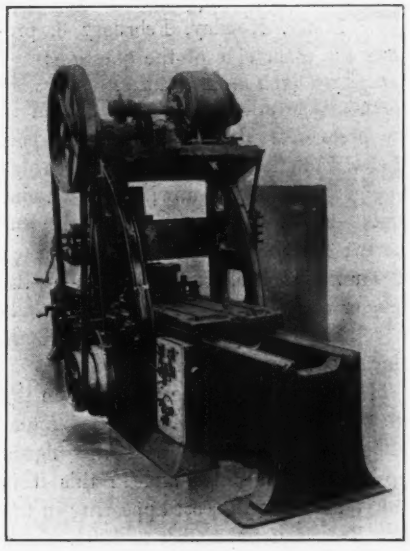
One of the recent changes in electrical practice is the general adoption of switchboard panels containing the control apparatus for individual motors. Before their introduction and in those installations where they are not yet used, controlling rheostats, line switches and protective devices have been mounted in the most convenient place available. The use of a panel ensures the proper mounting of the apparatus and provides a neat and convenient arrangement, with means for mounting in any desirable location.



MOTOR-STARTING PANEL WITHOUT FIELD RHEOSTAT.

MOTOR-STARTING PANEL WITH RHEOSTAT.

The accompanying illustrations show two of the styles of starting panels for direct-current motors designed by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., and employing a two-pole type D circuit-breaker instead of the customary switch with fuses. The circuit-breaker is especially adapted for this use, as one pole is connected in each leg of the circuit, the poles closing independently but tripping simultaneously. In closing the circuit, if there is an overload upon the line, the pole first closed opens immediately upon closing the second, thus instantly interrupting the circuit and preventing damage. It is strongly built, with few parts, none of which is small. It is provided with hinged, movable contacts of the brush type, and with carbon tips to which the current is shunted when the circuit is broken, preventing sparking at the contacts. The circuit is fully broken at the contacts before there is any movement of the carbon tips. There are no springs except the strong strip of spring steel which carries the carbons, the blow of the armature tending to open the breaker and not simply to release the moving parts. The device is reliable in its action, and is adjustable for different loads.



MOTOR-STARTING PANEL APPLIED TO MACHINE TOOL.

These panels with circuit-breakers are furnished in two styles; those with field rheostats for motors requiring shunt field regulation for varying speed, and those without field rheostats for constant-speed motors. Since the field and starting rheostats accompany the motors, the price of the panel includes only the mounting of the rheostats.

A starting rheostat with minimum voltage release is generally employed with Westinghouse motors. As soon as the supply circuit is interrupted the rheostat automatically opens the circuit, making it impossible to damage the motor by restoring full line potential to the circuit when the motor is at rest.

The field rheostat ordinarily provided with Westinghouse motors is mechanically strong, and will stand continuously the field current of the machine with which it is used, in any position of the handle. No combustible material is used in its construction.

The slab is of slate, with a dull black marine finish, harmonizing with the black oxide finish of the apparatus. When ordered, brackets are supplied for wall mounting; or gas pipe frames of rigid construction (such as are used upon the Westinghouse type 7B panels) are provided for mounting upon the floor. Capacities range from one-eighth to fifty horse-power 110 volts and from one-eighth to 100 horse-power 220 volts. Sizes of panels vary from eleven by twenty-three by one inch to twenty by forty-eight by one and one-quarter inches, according to the space required for the apparatus; in capacities to ten horse-power, 110 volts, and thirteen and one-half horse-power, 220 volts; panels without field rheostats are made with front connections if desired.

These panels are designed in strict accordance with government specifications and answer all requirements of the most rigid inspection.

They are especially adapted for separate machine tool drive, being so designed as to permit mounting directly on the frame of the machine tool driven by the motor, as shown in the accompanying illustrations.

New District Offices of the National Electric Company.

Mr. A. W. Wyckoff has been appointed district manager for the National Electric Company, of Milwaukee, Wis., to operate in Pittsburg and the surrounding territory. Mr. Wyckoff is well known in that section, as he was previously district manager of the Bullock Electric Manufacturing Company, having been, prior to his taking the Pittsburg office, the general superintendent of the Bullock works at Cincinnati, Ohio. He is a graduate of Cornell, and served for some time in the Bethlehem Steel Works. Mr. Wyckoff has secured for the National Electric Company an order for five 300-kilowatt, 120-revolution, engine-type generators for the Carnegie Institute.

Messrs. Spranley and Reed have been made district managers of the National Electric Company for New Orleans and the surrounding country. Both Mr. Spranley and Mr. Reed are well known throughout the section of the country that they represent, and have for many years been among the most successful electrical engineers of the South.

The Peerless Thawing Transformer.

The rapid adaptation of electrical outfits for the thawing of frozen water pipes has created a demand for special transformers, in order to perform this service with the greatest facility. The Peerless Electric Company, Warren, Ohio, has designed an apparatus which eliminates the necessity of constructing a special transformer for this work. Realizing the very many central stations carrying reserve transformers for emergency requirements, the company has designed a regulating or choking coil that may be utilized with any make of standard transformer of sufficient size.

The apparatus consists of two coils of heavy copper bar, having large carrying capacity, in connection with which are two plunger cores of laminated steel. These cores are to be raised from or lowered into the coils for the purpose of either decreasing or increasing the amount of current, as desired, for various sizes and lengths of pipes. The current traversing the pipe is heavy enough to readily heat it to a degree of temperature for thawing purposes, but not heavy enough to cause injury.

TRANSFORMER REGULATOR FOR THAWING FROZEN PIPES.

The regulating coil is well made and simple in its working parts. The windings are given an insulating treatment that renders them waterproof, and they are then encased in a strong iron case. The core is raised and lowered by a simple device operated by a hand wheel with cable and ratchet attachment.

The apparatus is designed to be used with any standard 110-volt transformer, either sixty or 133 cycles, of capacities from ten to thirty kilowatts.

The choking effect of the coil is such that full normal current will flow in the secondaries of the transformer, even though the leads be short-circuited, when the plunger is inserted its full length in the regulator. The coils are equipped with heavy terminals for connecting up the cable leads.

The Cost of Lighting.

At the present time considerable attention has been attracted to New York city, because of an agitation in favor of a municipal lighting plant. Much has been written and said as to economies which might obtain with a city-owned and operated plant. The following communication, which appeared in the *New York Times,* Monday, February 6, presents the other side of the question:

To the Editor of the New York Times:

An article allowed wide circulation in the press of to-day, concerning the cost of electric lighting on the Brooklyn bridge does great injustice—unwittingly without doubt—to the electric light companies of the two boroughs. A characteristic error of municipal bookkeeping is made—the same error Mayor Carter Harrison recently fell into in publishing the cost of Chicago's municipal lighting.

The annual cost of electric light on the bridge structure is placed "in round numbers" at $20,000. But this figure represents labor only; and in this it is $3,937 less than the cost appearing in the *City Record* of September 3, 1904, where the aggregate labor charge for lighting the structure is placed at $23,937. Even this item (for labor alone much in excess of the total cost given for lighting the bridge) includes no administration expenses.

It should be understood also that the cost of fuel, estimated at more than $12,000 annually, and of labor, including firemen in the boiler room, and of removing ashes, are not included and do not appear as an element of cost in the lighting of the structure. Under an arrangement with the Brooklyn Rapid Transit Company, the steam required for operating the electric lighting plant is delivered to the engines without direct cost to the city.

The investment expenses, such as interest, depreciation and insurance, are also omitted. There is no item offsetting the taxes that would be paid by a private company, and the city is not charged with water. Corrected, at least in part, the items of expense should be as follows:

Labor	$23,937
Coal	12,740
Water	1,500
Carbons	1,350
Incandescent lamps	1,980
Repairs, electrical plant	2,000
Repairs, electrical equipment on the bridge structure	1,500
Fixed charges upon an investment of not less than $100,000 for generating plants, original and those now in use, and the electrical equipment of the bridge:	
Interest, 4 per cent	4,000
Depreciation, 7 per cent, allowing fifteen years of active life	7,000
Insurance or its equivalent in the risks assumed by the city, fire and accident, the latter for the public and the employés, 11½ per cent	1,500
Loss of taxes, 1½ per cent on half value	750
Total	$58,257

With these corrections, each arc lamp is costing the city annually $168.94; each incandescent lamp $29.

The article is subject to one further correction; the private lighting companies have offered to supply the Williamsburg bridge with arc lamps for $130; with incandescent lamps for $18 annually, not $146 and $25 respectively, as stated.

Permit me to draw to your attention that in the service of the bridge are no subway or underground costs. The system is entirely overhead. According to ex-Mayor Matthews, of Boston, who made a very careful investigation, the difference between the two methods of supply is nearly $40 annually. Thus, if these lamps were distributed over the city, their total cost would be over $200 annually, as compared with the private companies' price of $146 upon the streets and $130 on the bridges.

Mistake is also made in the statement that the system of lighting on the bridge is superior to that employed by the New York Edison Company—for the two systems are alike. The report that the Edison lamps suffered during the recent blizzard is also erroneous. A city official who was out during the storm for the special purpose of inspecting the lighting, afterward made a statement to the effect that he could not find a single lamp out of service. ARTHUR WILLIAMS.

New York, February 3, 1905.

Central Electric Company's Plant Burned.

The plant of the Central Electric Company, 264-270 Fifth avenue, Chicago, Ill., was destroyed by fire on Saturday, February 11. It is suspected that the fire was of incendiary origin, and an investigation is now under way. The company is having little difficulty, however, in filling all of its orders, its arrangements for reserve supplies being highly efficient and meeting all demands at the present time at its temporary quarters, 209 East Jackson Boulevard.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW SOUTH CAROLINA WATER-POWER PLANT—The Oconee Light and Power Company is to utilize the lower White river falls, at Walhalla, S. C., for the generation of electricity for lighting Walhalla and other towns, and supply manufacturing plants in the vicinity. It is expected that 1,200 horse-power can easily be obtained.

NEW STORAGE BATTERY COMPANY—The Adams Storage Battery Company has filed articles of incorporation at Camden, N. J., with a capital stock of $4,000,000. The company is authorized to purchase and combine various storage battery companies. The incorporators are Henry F. Stockwell, Joseph Tyler and E. G. C. Blakely, of Camden.

NEW ENGLAND TELEPHONE COMPANY ENLARGEMENT—On February 7, in the general assembly at Hartford, Ct., a resolution was offered empowering the Southern New England Telephone Company, of New Haven, Ct., of which Morris F. Tyler is president, to increase its capital stock from $5,000,000 to $10,000,000. It is said that the company is making provision for future development of the telephone business, and is planning for extensions.

ST. LOUIS ROADS IN LARGE CONSOLIDATION—Negotiations are under way between the North American Company and Brown Brothers & Company, for the purchase by the former company of all the street railway systems in St. Louis. The North American Company already has extensive interests in St. Louis, both in street railway and electric and gas lighting plants. It is understood that some $90,000,000 is involved in the purchase price.

NEW HYDROELECTRIC PLANTS IN ITALY—Application has been made by L. M. Ciurlo, a civil engineer of Genoa, Italy, for a concession to use 450 litres of water per second from the Laccio waterfall, in the commune of Tarriglia. He proposes establishing a power plant there for industrial purposes and electric traction. The estimated cost of the works and machinery is $125,000. A similar project is advanced by Curletti and Erba, of Milan, for the appropriation of sufficient water from the Val Paghera and Val Pallobia falls, in the district of Brescia, to produce 7,840 horse-power. The cost of the works and machinery incidental to this concession is estimated at $155,000.

NEW MEXICAN ELECTRIC RAILWAY—A company has recently been organized in Mexico for the purpose of constructing and operating an electric railway from the city of Guadalajara to the town of Patzcuaro, in the state of Michoacan. The company is designated as the Ferrocarril, Jalisco and Michoacan, and is composed of some of the wealthiest Mexicans in the state of Michoacan. The proposed road will be about 200 miles long, the concessions for its construction having been obtained some time ago from the Mexican government. The road will handle freight as well as passenger traffic. The company has a capital stock of $1,500,000.

MISSISSIPPI RIVER POWER PLANT—The Keokuk & Hamilton Water Power Company has been authorized to construct a dam across the Mississippi river at Hamilton, Ill. It is estimated that the cost of the dam, lock and electric power plant that will be installed will be about $5,000,000. The promoters hope to furnish power not only to Keokuk and Hamilton, but to various cities within a radius of seventy-five to one hundred miles. The company is required to build a dam and put in locks sufficient for the present commerce of the river, and to furnish the government drydock facilities. Five years are allowed for the company to begin the work, and it must be completed in ten years.

CHANGE OF OWNERSHIP OF SCHENECTADY RAILWAY COMPANY—The negotiations for the sale of the Schenectady, N. Y., Railway Company to New York Central and Delaware & Hudson interests have been consummated. The formal transfer of the entire property was made a few days ago. It is understood that the purchase price was about $2,000,000, in addition to assuming the bonded indebtedness. The board of directors has been changed so as to make room for some of the new owners. Messrs. Parsons and Peck, of the old board, still remain in the new directorate. Mr. Edward F. Peck remains general manager of the company. The local officials report, it is understood, to Vice-President Culver, of the Delaware & Hudson, at Albany.

THE MUNICIPAL LIGHTING PLANT IN NEW YORK CITY—At the meeting of the New York Board of Estimate, held on February 10, the preliminary report of the commission appointed by Mayor McClellan to prepare plans for a municipal lighting plant was presented. The members of the commission are Dr. Cary T. Hutchinson, Professor George F. Sever and Nelson P. Lewis. The report deals only with plants for lighting the streets, parks and public buildings. The estimated cost of building plants for providing 6,000 arcs and 250,000 sixteen-candle-power incandescent lamps is $4,100,000, exclusive of the cost of real estate. The sites have been decided upon for power-houses, but the locations were not made public, in order that private conferences might be had with the comptroller of the city, and options obtained on the sites. The report states that the total cost of a power station having a capacity of 10,000 kilowatts, exclusive of the real estate, will be $1,250,000. The cost of high-pressure cables, substations and other details for 6,000 arc lights and 250,000 incandescent lamps is $2,850,000. The estimated cost per year of arc lights, including interest on bonds and depreciation of plant, is placed at $75.40. The cost per year of sixteen-candle-power incandescent lamps is fixed at $5.15. The total annual cost of operating the proposed plants is estimated in the report at $906,000. The estimates do not include any cost for the construction of ducts or rental for them. The contention is made that the city has the right to use the ducts of the private subway companies. The general plan suggested in the report provides for a power station for Manhattan and the Bronx, one for Brooklyn and Queens, and a third for Richmond. No reference is made to extending the system for the provision of light for private consumers.

NEW PUBLICATIONS.

COMMERCIAL RELATIONS OF THE UNITED STATES—The department of commerce and labor, Washington, D. C., has issued the second volume of "Reports on the Commercial Relations of the United States with Foreign Countries." This covers the year 1903, and contains consular reports from North America, Central America, the West Indies, South America, Asia, Australia, Oceania and Africa.

ENGINEERING SOCIETIES.

THE FARADAY SOCIETY—The transactions of the Faraday Society for January, 1905, contain the following papers and discussions which they provoked: "Measurement of the Potential of the Electrodes in Stationary Liquids. The Determination of Changes of Concentration at the Cathode During Electrolysis," by H. J. S. Sand; "Electrolytic Oxidation of Hydrocarbons of the Bunsen Series, the Methyl Group," by H. D. Law and F. Mollwo-Perkin; "Recent Investigations Bearing on the Theory of Electrolytic Dissociation," Louis Kahlenberg; "Potential of the Hydrogen-Oxygen Cell," by F. J. Brislee; "The Electric Furnace, Its Origin, Transformations and Applications," by Adolphe Minet; "The Electrolytic Analysis of Cobalt and Nickel," by F. M. Perkin and W. C. Prebble. This is the first issue of the transactions as an independent publication.

TELEPHONE AND TELEGRAPH.

EUSTIS, FLA.—The Eustis Telephone Company will increase the capacity of its switchboard.

LINCOLN, NEB.—The Nebraska Telephone Company has just completed a short line north of Havelock.

BUTLER, PA.—The new telephone line between Butler and Pittsburg has been opened for regular business.

LEWISBURG, TENN.—The citizens of Chapel Hill have decided to establish a telephone exchange at that place.

MEXICO, MO.—The Mutual Telephone Company, of Rowena, has arranged to build a telephone line from Rowena to Centralia.

KNOXBORO, N. Y.—The Richmond, Brewer & Madison Mutual Telephone Companies will build a line from Knoxboro to Oriskany Falls.

ACKERMAN, MISS.—The Cumberland Telephone Company has been granted a charter, and will put in a telephone system in Ackerman.

AVALON, CAL.—Direct communication has been established between Santa Catalina Island and Los Angeles by the Pacific Wireless Telegraph Company.

QUINCY, ILL.—The Quincy city council has unanimously voted for an ordinance requiring that in the future all telegraph and telephone wires shall be placed underground.

CONCORDIA, KAN.—The Concordia telephone system has passed into the hands of a new company, of which F. W. Daugherty is president and general manager, and F. J. Hannum, secretary-treasurer.

SPOKANE, WASH.—The Pacific States Telephone and Telegraph Company will install improved telephones throughout the city of Spokane. On December 31, 1904, there were 7,230 telephones in use.

GENEVA, N. Y.—The Clifton Springs Telephone Company has been purchased by the Consolidated Telephone Company, of Buffalo. The Clifton Springs exchange has at present about 100 telephones. The new owner will rebuild the entire system in Clifton Springs.

MIDDLETOWN, N. Y.—At an adjourned special meeting of the directors of the Orange County Telephone Company a contract was signed with the Hudson River Telephone Company, and the Orange County company is no longer affiliated with the independent companies of Orange and Sussex counties.

NASHVILLE, ILL.—The Nashville Rural Telephone Company has been organized. The officers are: president, J. J. Randall; secretary, Christ Buhrmeister; treasurer, Samuel T. McKelvey. The company will erect a system for the benefit of the farmers. Over eight miles of lines have been planned for, and poles, wires, telephones and other equipment have been contracted for.

PORT TOWNSEND, WASH.—The general opening of the Port Townsend-Seattle branch of the Pacific Wireless Telegraph Company's system took place on January 14. The formal opening of the system took place October 17, 1903, when the stations at Port Townsend and Fort Casey were placed in communication. Since then stations have been added at Friday Harbor, and on the revenue cutter Grant. Others are to follow at Victoria, Cape Flattery and points on the Alaskan coast.

MONTREAL, CANADA—The Bell Telephone Company has announced that it will carry on extensive work in Manitoba and the West during the coming year. The plan will include the erection of ten to fifteen central exchanges in the towns and villages not yet occupied, and the opening of twenty to twenty-five toll stations at villages not already reached by the company's lines. Several additional lines will be erected to keep up with the increasing business to points in Dakota, Minnesota and Wisconsin.

PEORIA, ILL.—The annual meeting of the Mutual Telephone Company, of Minier, was held recently, when all old officers were reelected as follows: president, John F. Quigg; vice-president, William Buehrig; treasurer, R. J. Mitchell; secretary, B. F. Quigg; directors, John F. Quigg, C. F. Wullenwaber, R. C. Crihfield, R. J. Railsback and William Buehrig. The company has passed its dividends the past year, putting its earnings and quite an additional sum into betterments, so that the physical condition of the system is excellent.

GRAND RAPIDS, OHIO—The Crescent Telephone Company held its annual meeting at Weston, and elected officers as follows: president, John Bonner, of Weston; vice-president, S. Cottingham, of Deshler; secretary, Azor Thurston, of Grand Rapids; treasurer, W. D. Mudge, of Weston. The company is one of the largest independent companies in northwestern Ohio which operates in small towns, having exchanges at Grand Rapids, Weston and Deshler, with lines extending from these exchanges into the country and all near-by towns.

DES MOINES, IOWA—The Iowa Telephone Company is preparing to construct eight toll lines out of Des Moines, commencing early in the spring. The lines are intended to extend from Des Moines in several directions to the state line, and are to be devoted exclusively to the business of larger towns. Sioux City, Omaha, Davenport, Clinton and Dubuque will probably be terminals of five of the lines, while other lines will probably extend north to Minneapolis and St. Paul, and south in the direction of Kansas City and St. Louis.

ALLENTOWN, PA.—The annual meeting of the stockholders of the Consolidated Telephone Companies was held recently, when the following directors were elected: G. O. Albright, Allentown; George R. Bedford, Wilkesbarre; W. L. Connell, Scranton; Thomas Daugherty, Allentown; F. M. Green, J. P. Helfenstein, Shamokin; C. W. Kline, Alvin Markle, Hazleton; R. E. Wright, Allentown; Isaac Hiester, A. J. Brumbach, W. Kerper Stevens, Reading; W. J. Hartzell, Allentown; A. P. Trautwein, Carbondale, and W. A. Lathrop, of Wilkesbarre.

GLENWOOD SPRINGS, COL.—The Colorado Telephone Company has notified the different exchanges on the western slope of the purchase of the Western Slope Telephone Company, which owns lines extending from Rifle through Meeker, Hayden, Craig, Steamboat Springs and Hahns Peak to Wolcott, a distance of 250 miles. It is understood to be the intention of the purchasing company to put in a new copper circuit over the entire line, and to make it equal to its lines elsewhere in the state. It is said that the company intends to connect from Steamboat Springs with the line which is built into Middle Park from Georgetown by Fred Rockwell and associates about five years ago.

WAPAKONETA, OHIO—At the annual meeting of the stockholders of the Peninsular Telephone Company, of Florida, in which a number of Ohio citizens are interested, the following board of directors was elected: W. G. Brorein, Buckland, Ohio; Guy Huffman, St. Mary's, Ohio; George K. Detweiler, Toledo, Ohio; J. H. Goeke and W. H. Hauss, Wapakoneta, Ohio; W. U. Lathrop, Bradentown, Fla., and J. J. Lunsford, Tampa, Fla. The officers of the company are W. G. Brorein, president; W. H. Hauss, vice-president and secretary; Guy Huffman, treasurer, and J. J. Lunsford attorney. It was decided to enlarge the plants at Tampa and a number of other cities, and to construct more toll lines, including an extension to Jacksonville, Fla.

NEWARK, OHIO—The Newark Telephone Company has elected the following directors and officers: president, Harry Swisher; vice-president, J. C. Brennan; secretary, C. H. Spencer; treasurer, Edward Kibler; E. T. Rugg, W. S. Weiant, J. J. D. McNamar. It is reported that the company now has 75,000 feet of cable strung in Newark, and that the exchange had grown in the past year from 1,203 telephones to 1,811. In the past year $21,038 has been spent in additions to the property, which is valued at $180,000, including the Granville exchange, which is valued at $10,000. Besides paying dividends on common and preferred stock the company last year spent nearly $10,000 out of the earnings in the extension of the plant. By a unanimous vote the stockholders voted to increase the capital stock from $100,000 to $150,000, by issuing $50,000 six per cent preferred stock.

ELMIRA, N. Y.—At the annual meeting of the New York State Telephone Company the following officers were elected: president, W. D. Barnard, of Philadelphia; vice-president, Edward Davis, of Philadelphia; treasurer, E. M. Yarnall, of Philadelphia; secretary, Boyd McDowell, of Elmira; general superintendent, G. B. Wright, of Binghamton. The report of Vice-President Davis showed an increase in telephone connections from 3,617 telephones on January 1, 1904, to 4,231 telephones on January 1, 1905, and an increase in revenue of over $1,000 each month during the year. Besides this increase in the number of telephones at local exchanges the company has completed its long-distance line from Elmira to Owego and Binghamton, and a line from Towanda to Canton, Pa. A new exchange has been established at Endicott, N. Y., where a switchboard is now being installed.

PERSONAL MENTION.

MR. FRANK KING, Bristol, Pa., has been appointed superintendent of the Hammonton, N. J., Electric Light Company.

THE HON. LUTHER R. MOORE, of Saco, Me., has been elected president of the York Light and Heat Company, succeeding the late Mr. George P. Westcott.

MR. T. L. ROSE, for several years local manager at Cameron, Tex., for the Southwestern Telephone Company, will go to Yoakum as manager of the company's exchange in that city

MR. FRANK TRUMBULL, of the Trumbull Electric Manufacturing Company, Plainville, Ct., is traveling in South and Central America. Mr. Trumbull has secured a large number of Cuban orders, and reports that business is very brisk in the new territory.

MR. MUNSON D. ATWATER has been appointed district superintendent at Indianapolis, Ind., for the Central Union Telephone Company. His position as local manager will be filled by Mr. W. R. Hirst, formerly superintendent of the Cleveland Telephone Company.

MR. E. J. BURNS, Rock Island, Ill., has been appointed manager of the Rock Island and Moline exchanges of the Union Electric Telephone and Telegraph Company. Mr. H. H. Pratt, who has been manager of the Tri-City exchanges for the past year, will be manager of the Davenport, Iowa, exchange.

MR. FRANK H. HARRIS has been elected superintendent of the street railway and electric light and power system in Anderson, S. C. He was formerly connected with the Birmingham Machine and Foundry Company, and later with the electric light and power department of the Birmingham Railway, Light and Power Company.

OBITUARY NOTICES.

MR. WILLIAM B. COMSTOCK died at his home in Alpena, Mich., February 7, aged sixty-two. He was a prominent lumberman and banker of that town, and was one of the original promoters of the Rochester & Eastern Rapid Railway.

MR. NATHANIEL R. FERGUSON, secretary and treasurer of the Missouri & Kansas Telephone Company, died on January 30, at his residence in Kansas City. Mr. Ferguson was born in New Holland, Ohio, in 1853, and went to Kansas City in 1865 with his father. Since the organization of the Missouri & Kansas Telephone Company in 1882, Mr. Ferguson had been an officer, holding his last position for about five years.

MR. FREDERIC H. CURTISS, contracting superintendent of the Kansas City Home Telephone Company, died at his residence in Kansas City, Mo., on the afternoon of January 29. Mr. Curtiss was a graduate of the University of Minnesota. He was contracting manager of the Twin City Telephone Company, of Minneapolis, until the Home company was started in Kansas City. He was a member of the University, Railroad and Commercial clubs, of Kansas City, Mo.

ELECTRICAL SECURITIES.

Although the market was at various times decidedly irregular during the past week, the values at the close were practically higher than for any week during the present year. The trading is estimated, however, to have been largely professional, and influenced by a desire to attract public attention. In this direction, however, there has been considerable failure of late, as, outside of a demand for high-class investments, the public is neither buying with great activity nor unloading, even though real declines take place. Despite this attitude of aloofness on the part of the public, it is held, in many quarters, that this is not a matter of suspicion, but is rather a disposition to wait until a new boom takes place. The passage of the railroad rate regulation law by the House of Representatives affected the stock market but little, it being the consensus of opinion that, with the early recess of Congress, the measure can not be pushed through the Senate this session. There continued to be indications of expanding industrial prosperity in almost every line. The production of iron for January established a record, in that it amounted to 1,176,500 tons, against the previous best monthly record of 1,713,000 in May, 1903. Railroad earnings have also been showing improvement, and while the gains over last year are not large, they have been general for roads in all sections of the country.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 11.

New York:	*Closing.*
Brooklyn Rapid Transit	62⅜
Consolidated Gas	208¼
General Electric	187
Interborough Rapid Transit	218
Kings County Electric	200
Manhattan Elevated	174¾
Metropolitan Street Railway	122¼
New York & New Jersey Telephone	171
Westinghouse Manufacturing Company	190

The results of the operations of the Brooklyn Rapid Transit Company for the year ending December 31, 1904, are as follows: gross, $15,459,660; expenses, $9,261,915, leaving net of $6,197,745; other income, $237,141, making a total of $6,434,886; charges and taxes, $4,961,614; surplus, $1,473,271, as compared with $1,138,217 for 1903, an increase of $335,055. In January, 1905, gross earnings of the system increased $110,000. If earnings are maintained at this rate for the rest of the current fiscal year the system will show gross earnings for the fiscal year ending June 30 next of over $16,000,000.

The report of the Interborough Rapid Transit Company for the three months ending December 31, 1904, shows that the surplus for the last quarter of 1904 was $439,569. A report on transportation for six months states that the number of passengers carried from July 1, 1904, to December 31, 1904, was 155,557,136, an increase of 22,254,345. There were 90,105,066 passengers carried during the three months ending December 31, an increase of 16,245,582 over the same three months the previous year. In the quarterly report the gross earnings were $4,472,855, an increase of $815,145; the net earnings, $2,584,768, an increase of $323,453; the total income, $2,680,781, an increase of $333,068, and the net income, $853,569, being an increase of $103,234. The operating expenses of the road increased $491,692, the total operating expenses being $2,584,768. The net earnings for the six months ending December 31 were $4,448,628, being an increase of over half a million dollars.

Boston:	*Closing.*
American Telephone and Telegraph	142¾
Edison Electric Illuminating	250½
Massachusetts Electric	55¼
New England Telephone	136
Western Telephone and Telegraph preferred	103

Philadelphia:	*Closing.*
Electric Company of America	10⅝
Electric Storage Battery common	78
Electric Storage Battery preferred	78
Philadelphia Electric	10½
Philadelphia Rapid Transit	28⅞
United Gas Improvement	113¾

The board of directors of the Philadelphia Rapid Transit Company has disposed of an issue of $10,000,000 4 per cent bonds at par. They are fifty-year first mortgage bonds upon the property of the Market Street Electric Railroad Company, and are guaranteed by the Philadelphia Rapid Transit Company. There will be turned over to the company for immediate use for the building of elevated and underground lines $5,000,000, and the balance as required from year to year for the extension of the system.

Chicago:	*Closing.*
Chicago Telephone	143
Chicago Edison Light	157
Metropolitan Elevated preferred	61½
National Carbon common	43
National Carbon preferred	113
Union Traction common	13
Union Traction preferred	50

The receivers of the Union Traction Company have secured $400,000 by floating certificates in New York.

ELECTRIC LIGHTING.

EDGAR, NEB.—The electric light plant has been completed and placed in operation.

SEATTLE, WASH.—The municipal electric lighting plant has been placed in operation.

LITHONIA, GA.—The Panola Light and Power Company has completed the work of wiring Lithonia for electric lights.

LANSING, MICH.—Citizens of DeWitt have made arrangements with the Lansing & Suburban Traction Company to furnish electric lights for the village.

GOODWATER, ALA.—Arthur Salmon has secured a franchise to install an electric light plant in Goodwater, and hopes to have the town lighted by May 1.

SYRACUSE, N. Y.—Officers of the Syracuse Lighting Company plan an expenditure of over $100,000 for the improvement of their lighting system and the betterment of the service.

WATKINS, N. Y.—The electric light plant of the Watkins Consolidated Gas and Electric Light Company was burned on February 3. Watkins will be in darkness until a new plant is erected.

LOGANSPORT, IND.—At a meeting of the Flora town council a franchise was granted to David Milles for an electric light plant. The contract calls for fifteen arc lights at $80 each per year.

ROYALTON, MINN.—Royalton is soon to commence the installation of an electric light plant, it having just floated $10,000 of bonds for this purpose. The bonds brought $10,371, with ten bidders in the field.

ELLENSBURG, WASH.—Ellensburg is now lighted with electricity from the water-power plant, situated on the river three miles above the town. The new plant has a capacity of 1,000 horse-power.

PITTSBURG, PA.—The People's Light and Power Company, recently organized at McKeesport, has been granted a franchise by the select council of Pittsburg to erect poles and string wires on every street.

CLEVELAND, OHIO—The council has confirmed a contract with the Cleveland Electric Illuminating Company to light the streets at a cost of $73.65 per arc light per year. The total will be over $150,000.

REARDAN, WASH.—J. M. McDowell has begun the work of installing the electric plant for which the Reardan council recently granted him a franchise. He expects to have the town lighted by March 1.

STERLING, ILL.—The Lee County Lighting Company, of which H. C. Higgins is the manager, has acquired the titles and ownership to the dam and hydraulic plant of the Dixon Power and Lighting Company. The consideration is given as $200,000.

BUFFALO, N. Y.—Application for permission to erect poles, lay conduits and wires in the different streets of Buffalo has been asked of the board of aldermen by the Iroquois Electric Light Company, which was recently incorporated by a number of prominent men of Buffalo.

NEW BRUNSWICK, N. J.—The Carteret Electric Light, Heat and Power Company, at a meeting of the stockholders held at Rahway, decided to sell its stock to the Public Service Corporation. The par value of the stock is $100, and the Public Service Corporation paid $150 a share for it, giving a bond issue as payment.

SPOKANE, WASH.—It is rumored that the Spokane Light and Power Company, composed of George Turner, F. P. Hogan, J. C. Williams and others, and which has a franchise in Spokane to lay wires for electric lights, electric heat and electric power purposes, is preparing to take advantage of its franchise and install a system.

STILLWATER, MINN.—The Stillwater Gas and Electric Light Company has amended its articles of incorporation so that money can be raised wherewith to pay off the old bonded indebtedness, construct a new gas works in Stillwater, and take over the property of the Apple River Power Company, which generates electricity for Stillwater. The articles provide that the company can have an indebtedness of $500,000.

TROY, N. Y.—At an early meeting of the Cohoes common council it is understood that the Hudson River Water Power Company will make application for a franchise, with the privilege of constructing a power line to Cohoes, so that it may furnish electric power to Cohoes manufactories. It is understood that the advent of the company in Cohoes is favorably looked upon by many business men, and it is likely that the company will be granted a franchise when it applies for it.

EDUCATIONAL.

BULLETIN OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY—The bulletin of the Massachusetts Institute of Technology, Boston, Mass., just issued, contains the president's report for the past year, discussing the condition of the institute, and the reports of various heads of departments, together with a number of statistics relative to the work being carried on.

JOHNS HOPKINS UNIVERSITY—The Johns Hopkins University, Baltimore, Md., will hold its annual exercises, commemorative of the opening of the university, on the twenty-second of February. The principal address will be delivered by Dr. William Osler, professor of the principles and practice of medicine. The exercises will begin punctually at eleven o'clock in McCoy Hall.

CATALOGUE OF THE STEVENS INSTITUTE OF TECHNOLOGY—The Stevens Institute of Technology, Hoboken, N. J., has issued its annual catalogue for the year 1905-1906. This contains a large number of half-tone photographs of the buildings, and interior views of the various shops, laboratories and classrooms are also shown. Requirements for admission and descriptions of the courses are given, together with sample entrance examination papers, a list of the students, subjects of theses for the class of 1904, and a complete list of the alumni.

WORCESTER POLYTECHNIC INSTITUTE—The thirty-fifth annual catalogue of the Worcester Polytechnic Institute has been issued. It is a volume of 214 pages, giving full information in regard to entrance requirements, courses of study, equipment, etc., lists of alumni with their present occupation, and similar information. The present catalogue shows that the force of instruction consists of a faculty of sixteen professors and assistant professors, and twenty-one instructors and assistants, besides assistants in the Washburn shops. The student enrolment is the largest yet recorded, being 324. Last June the institute graduated forty bachelors of science in the various courses. It conferred also the degree of master of science upon two candidates, the professional degree of mechanical engineer upon two, that of electrical engineer upon one and the degree of doctor of science for the first time upon one. These degrees are all conferred for work done, since the institute confers no honorary degrees.

UNIVERSITY OF WISCONSIN—The Carnegie Institution, of Washington, D. C., has recently made a grant of $2,500 to Professor C. F. Burgess, of the department of applied electrochemistry of the College of Engineering, University of Wisconsin, to aid him in carrying out investigations upon the properties of pure iron and its alloys. During the past three years, Professor Burgess has developed a method of producing iron electrolytically of a very high degree of purity, in a manner similar to that employed in the refining of copper. Previous to this work pure iron had been obtained only in very small quantities, and at excessive cost, but Professor Burgess is now able to produce comparatively large quantities at a small cost, using for this purpose a cheap grade of steel. Careful analysis of this product fails to show the presence of any foreign element, with the exception of hydrogen, which can readily be driven off by heat. There is already a considerable demand for this iron for scientific purposes, and about half a ton has already been made. The possibility of producing pure iron on a comparatively large scale opens up a very promising line of investigation with reference to the qualities of the pure iron itself, and of any desired alloy with other elements. The importance of this line of research has been recognized by the above-named grant of $2,500 for the current year.

ELECTRIC RAILWAYS.

PORT JERVIS, N. Y.—The Intervale Traction Company, which is preparing to build an electric railway between Goshen and Newburgh, has elected H. B. Odell, president; Louis Stotesbury, vice-president; W. Johnston McKay, secretary and treasurer.

PITTSBURG, PA.—The Munhall & Homeville branch of the Pittsburg Railways Company is to be extended for a distance of two miles into Bull Run, Mifflin township. It is announced that the extension will be commenced as soon as the weather permits. There are several hundred families living in the vicinity which the proposed line will traverse.

HUNTINGTON, IND.—The city council of Warren has granted a franchise through the town to the Breed-Shideler interests, which propose to build an electric line from Marion to Warren and there connect with the Portland, Montpelier, Warren & Huntington traction line. The latter road, it is said, has been financed and will be built this summer. The Breed-Shideler interests own the Marion & Wabash traction line, which has been in operation since last summer.

ALLENTOWN, PA.—The annual meeting of the Allentown & Reading Traction Company was held recently at Allentown. These officers were elected: president, H. E. Ahrens, Reading; vice-president, Solomon K. Hoffman, Hamburg; secretary, Asa R. Beers, Mauch Chunk; treasurer and assistant to the president, George B. Schaffer, Reading. Directors, W. D. Mohn, Mohnsville; John M. Kutz, Mahanoy City; P. L. Diener and Frank R. Wagner, Hamburg; Jas. S. Ahrens and G. H. Gerber, Reading.

MEMPHIS, TENN.—The Clarksville Electric Street Railway Company has filed an application for an amendment to its charter, increasing the capital stock from $20,000 to $25,000. It is also sought to change the name to the Clarksville Railway and Light Company. The amendment will likewise authorize the extension of the lines of the company to the Kentucky-Tennessee state line, to a number of other points in adjacent territory and along some of the streets of Memphis now not occupied.

ZANESVILLE, OHIO—Rufus C. Burton, S. A. Weller and H. A. Sharpe, of Zanesville; Frank McCormick, of New Concord; and Samuel Nicholas, of Coshocton, are organizing a company, the object of which is the construction of an electric railway from Zanesville to Coshocton and New Philadelphia *via* New Concord, Adamsville and Coshocton, to connect with the line from New Philadelphia north to Cleveland. It is stated that agents have already procured almost all the required rights of way for the proposed line.

NEW ORLEANS, LA.—Stock and bondholders of the New Orleans Railway Company, of Trenton, N. J., which recently went into the hands of receivers have appointed a committee of five to perfect plans of reorganization looking to the purchase of the company's properties. The members of the committee are R. M. Walmsley, New Orleans; John W. Barr, Louisville; I. L. Lodewk Pierson, Amsterdam; J. A. Blair and Otto P. Bannard, of New York. It is understood that they were appointed through the New York Securities and Trust Company, which undertook to underwrite the company's securities.

NEW HAVEN, CT.—An official statement, issued from the offices of the New York, New Haven & Hartford Railroad, says that at a meeting of the board of directors of the Berkshire Street Railway Company, held in New Haven, the old board of directors resigned and the following were elected: C. S. Mellen, C. F. Brooker, D. Newton Barney, William Skinner, Arthur D. Osborne, H. M. Kochersperger, E. H. McHenry, Calvert Townley and James S. Hemingway. These men are directors of the Consolidated Railway Company, the corporate name of the concern through which the new York, New Haven & Hartford Railroad has already taken over various electric lines in Connecticut. Officers were chosen as follows: president, C. S. Mellen; vice-president, E. H. McHenry; treasurer, A. S. May; clerk, J. G. Parker. Calvert Townley was appointed assistant to the president.

WASHINGTON, D. C.—The annual report of the Anacostia & Potomac Railroad Company has been made public. It shows a capital stock of $2,000,000, divided into 40,000 shares, of which $1,998,100 has been paid in. The total amount of the funded debt is $2,517,000, and there is no floating debt. The length of the road is shown to be more than sixteen miles, the total cost having been $4,241,911.89. The total number of passengers carried during the year was 9,874,521. The total receipts during the year were $304,252.31, divided as follows: passengers, $297,000.69; chartered cars, $720; mail, $377.64; advertising, $1,285.20; rents, $50; interest, $4,818. The expenses of operating and repairs are $176,092.53, divided as follows: maintenance, $8,049.63; equipment, $18,240.80; miscellaneous, $15,543.82; employés, $78,969.95; power and transportation, $42,752.38; damages, $7,623.53; rents and use of other roads, $4,912.42. The total operating expenses and fixed charges are given as $310,775.14. The deficit for the year is shown to be $6,523.83.

NEW COMPANIES.

CHICAGO, ILL.—The Kester Electric Manufacturing Company has been reorganized under the name of the Chicago Solder Company.

JERSEY CITY, N. J.—The Federal Railway Signal Company has been incorporated by Richard C. Fessende, of Orange; James Fraser Reid, of Newark, and John F. Gough, Jersey City.

NEW YORK, N. Y.—The Connecticut Dynamo and Motor Company has been incorporated with a capital of $17,000. The incorporators are D. McDonald, H. J. Brewer and J. P. Munn.

MONTCLAIR, N. J.—The Keystone Rail Joint and Supply Company has been incorporated with a capital of $100,000 by James Haway Griffith, Jr., Frederick G. Townsend and Clarence E. Thornall, all of New York city.

NEW YORK, N. Y.—The Kerr Electric Company has been incorporated with a capital of $1,000, to manufacture electrical goods. The incorporators are Duncan A. MacIntyre, Oliver B. Goldsmith, Arnold L. Davis, all of New York city.

LEGAL NOTES.

ELECTRIC FUSE LITIGATION—In the suit of the American Electric Fuse Company against the Rolfe Electric Company and Charles A. Rolfe, in the circuit court for the county of Lenawee, Mich., involving the ownership of the Rolfe pioneer self-soldering protector patents, a decision was handed down on February 4, in favor of the American Electric Fuse Company.

DECISION CONCERNING PATENTS FOR APPARATUS FOR MAINTAINING A CONSTANT CURRENT IN A SERIES ALTERNATING CIRCUIT—On February 6, 1905, Judge Archbald, sitting in the circuit court of the United States for the Eastern District of Pennsylvania, handed down a decision in the case of the Manhattan General Construction Company *versus* the Helios-Upton Company. The patents involved were Nos. 684,340 and 688,165, issued October 8, 1901, on the inventions of Malcomn H. Baker. These patents relate, respectively, to apparatus for maintaining a constant current in a series alternating circuit operated from high-potential mains, and the method of securing constancy of current by such means. Judge Archbald held the method patent invalid, as, in effect, the claiming of a principle. Claim one of the apparatus patent—No. 684,340—was also pronounced invalid, but claim four, as follows, was sustained: "In an alternating circuit a series of translating devices having a regulating reactance coil having a moving part adapted, when moved to different positions by the magnetic pull of the coil, to cause varying choking effects, the said moving part being acted upon by a force opposing the magnetic pull, which force is so adjusted throughout its effective range of operation as to counterbalance the magnetic pull when the moving part is in such positions with respect to the coil as are adapted to produce constant current." The defendants plead lack of infringements because of mechanical differences of construction. The Baker patent illustrates a device having a pivoted arm bent at a certain angle, a moving coil being at one end, and a compensating weight being at the other end of the arm. The Helios-Upton regulator has its moving coil mounted upon the end of a swinging pendulum arm, swinging upon an inclined U-shaped core, the pull of the coil on the core being coordinated with the increasing gravitational force as the coil was moved from the vertical toward the horizontal. The opinion states that the claims must be read in the light of the entire specification of the patent. A decree was ordered, and the case referred to a master for an accounting.

INDUSTRIAL ITEMS.

THE MEEK & BEACH COMPANY, Coshocton, Ohio, announce that after February 15 they will be known as the Meek Company. There will be no change in the management. This company manufacture signs and novelties for advertising purposes and are calling particular attention to their lithographed metal signs.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., held its annual stockholders' meeting on February 2. The retiring board of directors was reelected. The board includes E. M. Barton, Frederick B. Fish, Henry S. Howe, Alexander Cochrane, W. R. Patterson, Arthur D. Wheeler, H. B. Thayer, A. C. Bartlett, Charles Williams, Jr., Charles W. Amory and Thomas Sherwin.

THE ELECTRIC STORAGE BATTERY COMPANY, Allegheny avenue and Nineteenth street, Philadelphia, Pa., is distributing two handsome catalogues descriptive and illustrative of the chloride accumulator and the Exide battery for electric vehicles. This catalogue gives prices, weights and characteristics of the various cells, and should be secured by all prospective purchasers of this form of apparatus.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., increased its capital stock to $100,000 on February 7, 1905. It is the intention of the company to build a new four-story brick factory during the coming year. The present quarters have become too small for the largely increasing business. The company intends to make a specialty of the panel and switchboard business. Catalogue No. 5 is now ready for delivery, and will be sent upon request.

THE CHASE-SHAWMUT COMPANY, Newburyport, Mass., announces that H. F. Sanville & Company, Philadelphia, Pa., are handling the Shawmut soldered rail bond in their territory. William S. Brown, of New York; Thomas G. Grier & Company, Chicago; L. F. Mahler Company, St. Louis; Spranley & Reed, of New Orleans, and John R. Cole Company, of San Francisco, are handling a complete line of electrical specialties manufactured by the Chase-Shawmut Company, for their respective territories.

THE REYNOLDS-DULL FLASHER COMPANY, 177 Adams street, Chicago, Ill., is distributing a valuable catalogue descriptive of Reynolds-Dull flashers. This catalogue gives many valuable points on selecting a flasher. The various connections for two-wire and three-wire systems are shown, and the essential points to be considered in manipulating flashing signs are carefully indicated. The various forms of apparatus manufactured by the company, and their applications, are illustrated and described.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., has established a southwestern sales office in the city of St. Louis, Mo. Mr. E. J. Pietzcker, who has been attached to the western sales department of the company, with headquarters in Chicago, for the past two years, has been appointed manager of the new sales office, and will be located at 521 Security Building, St. Louis. Mr. Pietzcker has had many years' experience in the wire and cable business, and his long residence in the South will afford him facilities for renewing old acquaintances in that territory. Enquiries from Missouri, Kansas, Oklahoma, Indian Territory, Arkansas, Texas, Louisiana, Mississippi, New Mexico, the western half of Tennessee and Kentucky, and the southern half of Illinois, will be promptly served from this office.

THE IMPERIAL BRASS MANUFACTURING COMPANY, 245-247 South Jefferson street, Chicago, Ill., has been organized by Mr. Charles McNeil, for the manufacture of general brass and aluminum work in all branches. Mr. McNeil was connected for the past thirty-three years with the Turner Brass Works, of Chicago, serving as vice-president and general superintendent for the past sixteen years. Mr. W. S. Noyes, who has also been actively connected with the Turner Brass Works for nearly fourteen years, as secretary and treasurer, has associated himself with Mr. McNeil as secretary of the new company. The company is installing a complete line of the best modern machinery and tools, and will shortly be in a position to execute orders for brass, bronze and aluminum castings, plating, polishing and machining of all kinds, including screw machine and punch press work, and spinning and stamping in brass, aluminum and steel. The company will also be equipped for making special dies and tools to order, and wood and metal patterns.

THE CONSOLIDATED ENGINE-STOP COMPANY, 100 Broadway, New York city, calls attention to a decision of the supreme court of Rhode Island in the case of an employé's suit for damages, because of injury sustained through entanglement with a machine. It was shown that the friction clutch through which the machine was driven failed to work, but it was also proved that the machinery was stopped within six or eight seconds after the closing of a near-by push switch operating a Monarch engine-stop and speed-limit system. On this proof the employer was absolved from blame, and a verdict rendered in his favor. From time to time attention has been called to the number and seriousness of flywheel accidents, and the necessity of some automatic means of preventing steam engines from racing. The Consolidated Engine-Stop Company will be pleased to furnish complete information on this subject upon request.

W. R. OSTRANDER & COMPANY, 22 Dey street, New York city, are distributing the fourteenth edition of their large catalogue. In addition to the catalogue there is being distributed a twelve-page trade discount sheet applying to this catalogue. The catalogue illustrates and describes every variety of article and apparatus which has any bearing upon electrical construction. The articles listed include speaking tubes and whistles, electric bells and batteries, electric burglar-alarms, electric gas lighting material, watchmen's clocks, electromedical apparatus, line material and construction tools, electric lighting supplies, fan and power motors, arc and incandescent lamps, miniature lamps, novelties, electric heating specialties, telephones and telegraph systems, telegraph instruments and lightning arresters. The company also issue special catalogues describing fully their telephone instruments and electric fans. Any of these catalogues may be had upon request.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, 36 West Jackson Boulevard, Chicago, Ill., made an interesting exhibit at the recent convention of the Wisconsin Independent Telephone Association, Madison, Wis. This exhibit included the various types of magneto self-restoring drop switchboards, both the American express and the Bell express, and also all the different kinds of magneto and central energy telephones manufactured by the company. The Leich four-party selective signaling system was operated and shown to the visiting exchange managers and engineers. The new Burns adjustable telephone also attracted considerable attention. The company was well represented by General Manager J. G. Ihmsen, Sales Manager Max W. Zabel, Western Representative S. J. Bear, and the company's Indiana representative, H. A. Nuttall. The American Electric Telephone Company is issuing a number of bulletins, comprising a series of twenty, running from No. 7 to No. 26, any of which may be secured upon application.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces the following awards of the international committee of the Louisiana Purchase Exposition in recognition of the engineering ability of the designers of apparatus exhibited by the company: grand prizes have been awarded to Elihu Thomson, Swampscott, Mass., for various applications of electricity; to C. P. Steinmetz, Schenectady, N. Y., for electric lighting, and to F. J. Sprague, New York city, for applications of electricity to transportation. Gold medals have been awarded to C. G. Curtis, New York city, for a multistage steam turbine; to W. L. R. Emmett, Schenectady, N. Y., for vertical-type steam turbine and generator, and to W. B. Potter, Schenectady, N. Y., for applications of electricity to transportation. Silver medals were awarded to W. S. Moody, Schenectady, N. Y., for transformers; to E. M. Hewlett, Schenectady, N. Y., for distribution of energy, switchboards, etc.; to H. F. T. Erban, Schenectady, N. Y., for apparatus for generating electricity; to H. G. Reist, Schenectady, N. Y., for apparatus for generating electricity; to L. T. Robinson, Schenectady, N. Y., for scientific apparatus, measuring apparatus, and laboratory and standard instruments, and to F. P. Cox, Lynn, Mass., for measuring instruments, indicating, recording and integrating.